ENGINEERING NEWS

THE practical value of the induction system of train telegraphy, by which messages can be sent from moving trains, was well illustrated by its workings on the Lehigh Valley Railroad in the great blizzard. The regular telegraph lines were all down, but the induction line, which has been in use upon the New Jersey division, from Perth Amboy to Easton, for several months past, worked excellently throughout.

In one accident near Three Bridges the induction train telegraph operator at once telegraphed back for a wrecking train, which soon arrived, and during the entire day messages were sent to and from the wrecking train, and surgical relief was obtained. All the beleagured passenger trains, every one of which was equipped with the new system, were located by means of train telegraphy, and provisions were sent to the hungry passengers. More than 200 messages were sent back and forth over the single line of the company during the three days of the storm by belated passengers and others.

The poles used to carry the line are only 16 ft. high, and expose little surface to the storm. The messages are transmitted by induction from the metal roof of the car to the line, a distance of 10 ft., and even when cars and line were both buried in the drifts no inconvenience was suffered, as the dry snow did not interfere with the induction.

THE unanimous report of the Board of Engineers called in to consider the Buffalo grade crossing question, as we have previously noted, has been approved by the joint Committee of citizens and a bill prepared to carry it into effect. Both sides are satisfied with the modified BUCHHOLZ plan; both sides agree that the proper way to apportion the expense is through the agency of a commission appointed by the Supreme Court, and the railways are willing that the act creating the Grade Crossing Commission should clothe it with power to adopt a plan and abate the evil, if the railways decline or neglect to perform their contract.

The provisions of the bill in detail are these:

(1.) A commission shall be appointed to carry out the work.

(2.) The details shall be prepared by the City Engineer and a railroad engineer.

(3.) The work shall be done subject to the approval of the City Engineer and a bond of $50,000 furnishd by the road as a guarantee of good faith.

(4.) No changes or modifications shall be made without the consent of the City Engineer.

(5.) The cost of the work shall be apportioned by a commission to be appointed by the Supreme Court.

(6.) In case the railways neglect to carry the plan into execution, a commission clothed with full authority shall be appointed to go on with the work.

THE town of Brockville, Ontario, has lately succeeded in disposing of its sewage by discharging it into the St. Lawrence river by a 16 in. cast-iron pipe 930 ft. long, emptying into 45 ft. of water. This work has been carried out by the City Engineer, Mr. WILLIS CHIPMAN, and Mr. JOHN F. WARD, M. Am. Soc. C. E. A trench was first made on the river bottom, which latter curved gently with a versed sine of about 13 ft. in the 930 ft. Stools of light timber were set on 2 in. plank resting on the heavy ice and on each pair of these stools was a 6 by 8 in. timber. The pipe was jointed in the usual manner, seven flexible joints only being introduced in its length. The pipe was lashed by light rope over a 26 in. channel cut through the ice and at a given signal these ropes were cut, commencing at the shore, and the pipe settled rapidly and truly to its place. When the men failed to cut in time, the weight of the pipe broke the rope or the light timber crosspiece. The river-end of the pipe was closed by an iron plate leaded and caulked water tight. After the pipe was tested and found to be tight this plate was removed by an ingenious arrangement of leverbars and cams devised by Mr. WARD, which we hope to illustrate later.

WORK on the Hudson River tunnel, which was suspended last September for lack of funds, was resumed last week, but still without definite assurance of means to complete the tunnel, so far as we can ascertain. At the time of suspension the work was progressing at the rate of 4 to 5 ft. per day on the New Jersey end, where the material was a tenacious clayey silt, but was only advanced 200 ft. at the New York end, where the material is as yet sand. No special difficulties had arisen, however, and the heading was on the point of entering the silt when work was suspended. While this tunnel will go but a little way to fill the requirements of the situation when built, we hope to see it completed.

PHILADELPHIA is at last realizing that its rectangular system of streets is not altogether an unmixed blessing. It has the most magnificent park in this country and the most difficult, dangerous and disagreeable approach to this Park that can be conceived of. A project is now broached by Mr. E. H. PARRY, of the Baldwin Locomotive Works, and architect, F. G. THORN, which if carried out would open up a grand diagonal boulevard, starting at the new city hall and running straight to Fairmount Park. This boulevard would be 120 ft. wide with a central walk shaded by trees. It would cross no railway tracks, and aside from its advantages as a park entrance, would be a short-cut and great convenience to all the residents of the section effected.

THE quicksand trouble at the bottom of the shore shaft of the new lake tunnel at Chicago has been overcome at the expense of about 13 ft. of shaft which have been filled with concrete. The shaft was nearly 94 ft. deep when the trouble commenced; 4 ft. additional was sunk with the result of only developing more quicksand and water. The steel shell around the brick-work alone saved the shaft from wreck. Finally a 4 in. pipe was driven into the sand and the concrete packed around it; a pump attached to the pipe removed the water and sand immediately under the concrete and allowed the latter to settle to a firm bearing. Borings seem to indicate that had the shaft been sunk 50 ft. further south the quicksand pocket would have been avoided entirely. As stated elsewhere, work has now been commenced on the two lateral drifts.

THE shareholders of the Panama Canal, at a meeting held in Paris on March 1, were told that a sum of $130,800,000 was necessary to complete the canal on the revised plan. Of this sum $50,800,000 were for excavation; $25,000,000 for locks and masonry; $3,000,000 for storage reservoirs on the upper levels; $10,000,000 for materials and $42,000,000 for general expenses and interest account.

THE Bill abolishing the present Board of 20 Trustees of the Brooklyn bridge, and substituting therefore a Board of three trustees only has passed the Senate by a unanimous vote, as we presume it will likewise the Assembly, as the Bill was prepared and recommended by the Mayors of New York and Brooklyn and there is no open opposition. On the appointment of the New Board the present one lapses at once.

GERMANY, Sweden and Denmark have all been afflicted by a very heavy snow-storm, the accounts of which read very much like those of our own blizzard. As it came only five days later it is natural to suppose that it is a part of the same storm.

THE late decision of the U. S. Supreme Court in favor of the Bell telephone patent is, as might be expected, received by the press of the country with a varying degree of favor. The *Herald*, *Times*, *Tribune* and *World*, of New York, denounce the decision as a most unpopular one, as favoring fraudulent claims and patenting a principle in nature; the *Sun* alone of the powerful dailies rejoices because it "knocks the Pan-Electric combinations." As four of the judges held that BELL was the first inventor, and three judges dissented, the decision does not seem to definitely sustain the patent against the future. Eight judges will form this Court (Judge GRAY, the ninth, not sitting on any of these cases) and if Mr. LAMAR, the new judge, decides with the three dissenting, the Court will be tied. The Boston case is still on appeal before the U. S. Supreme Court and until that decision is in, the case is doubtful.

AGAIN, this week, within a few days after the great blizzard stoppage, the Brooklyn bridge cable traffic was suspended during two of the most crowded hours, 6 to 8 P. M., by a derailment "due to an open switch" on the New York side, as the newspapers report, but as it was only the rear car which was derailed it was probably due, in fact, to a plain jumping of the track. These accidents are becoming increasingly frequent as the switches wear and traffic becomes heavier, and must do so, especially as the turnout curves are excessively sharp, because of the contracted room; and such derailments are, of course, especially probable during the rush hours. As over 12,000 passengers per hour then use the bridge, the mere money loss is some $350 per hour, but that is only a fraction of the real loss to the public, most of whom would pay four or five times the fare to escape the delay and annoyance.

A THROUGH express train on the Savannah, Florida & Western Railway was wrecked by derailment on a trestle at 9:40 A. M. of March 17, when crossing the trestle approach to Hurricane creek, causing 23 deaths and about 35 injuries, making it the worst accident by far since the Chatsworth disaster, Aug. 10, 1887. An equally terrible destruction of life by fire was narrowly escaped by the presence of mind of the engineer, who left his fireman to run ahead with the engine, and himself extinguished the starting flames. The trestle is about 1,500 ft. long, and is at the foot of a grade. Where the train fell it is about 25 ft. high. Two-thirds of the trestle fell with the cars, and on the part left standing the cross-ties are all cut into splinters by the derailed wheels. The marks of broken axles dragging on the roadbed and trestle show for several hundred yards. The cars also were all splintered to pieces.

The train consisted of a baggage and smoking car, day coach, two sleepers and a private car. The leading car was derailed first and the reports make it clear that it was derailed some distance before reaching the trestle and had not wandered very far from the track when it struck the trestle, by which time several other cars were derailed. The lack of any proper system of guard rails and rerailing frogs at the end of the trestle prevented this harm being in any degree rectified and the wretched floor system of the bridge did the rest of it. As is but too common in the South—and the North too, for that matter—the trestle had only the ordinary short ties and no guard-rails, and was not very securely braced nor solidly constructed. Hence there was no hope for the train, once off the track.

A correspondent of the New York *World* (March 19) makes the following statements, we hope somewhat exaggerated, about the condition of the structures on the road. We reprint it because, if it be not true of that road it certainly is true of a good many others, and it will be well for everyone having charge of such structures to consider how desirable it is to have such statements appearing *after* a great accident:

"During February of this year myself and two friends had occasion to cross a large number of the trestles and bridges of the Savannah, Florida and Western Railroad during a hunting expedition between Savannah and the point where the accident occurred, and we found the bridges in a fearful condition. One can stand on a bridge and by merely jumping up and down shake the whole bridge, so that the structure trembles violently and every train that crossed we expected to see go through into the swamp. For miles this is the case. The ties are so rotten that a man dare not step with his whole weight upon them, and where they are entirely rotted away no new ones are put in. Where the bridges are so frequent, as just this side of Jesup for about twenty miles, it is awful to watch a fast express or vestibule train rush to almost certain destruction, as it seems, by the way the bridges sway and rock to and fro.

"I am ready to prove the above to be facts, and state again that the bridges are rotten, every fifth tie rotten to the core and decidedly unsafe. A bridge like one of these in the Middle States would arouse a great hue and cry.

THE Council of Chicago passed on March 19, an ordinance granting the South Side Rapid Transit Co. a right to construct an elevated railway across certain streets and alleys in the southern part of the city. The company is to deposit $100,000 with the City Treasurer as a guarantee that it will build the road, which sum is to be refunded when $200,000 has been expended in construction. It is to be built by a New York and Chicago syndicate.

Enlargement of the Capacity of the Brooklyn Bridge.

[Report submitted to the Board of Experts by A. M. WELLINGTON, C. E., describing the recommended plan. Concluded from p. 224.]

THE HORSE-SHOE CURVE.

The proposed radius of 90 ft. offers no impediment whatever. The elevated lines have a number of curves of 90 ft. radius, operated by locomotives in the ordinary way at 6 to 10 miles per hour (the guard rails being well greased however). The rails last about 18 months, and no trouble or threatened trouble has ever arisen from them.

These horse-shoe curves, however, are not to be passed over by locomotives, and as the car trucks are but little longer than a freight car truck there is no reason why the cars should not go over any curve that freight cars will, and freight cars pass curves every day in the streets of New York and elsewhere of less than 50 ft. radius. The only reason, therefore, for proposing even so large a radius as 90 ft. is to obtain a station area which will be adequate for all time to the requirements. Otherwise the curve *might* be considerably sharper, although of course an easy radius is always preferable.

Whatever the radius, it makes no difference what the speed is, provided the outer rail can be elevated to *precisely* correspond to the speed, and the radius of the curve at every point. By the plans here outlined every train will have the constant speed of the cable at all times, and by connecting the sharp curve to the tangents by transition curves of gradually increasing radius, as it is proposed to do, the elevation may always be precisely adapted to the radius of the curve as well.

Under these conditions, with *precisely* uniform speed, and *precise* adaptation of the elevation to the speed and radius of curve, it will not be possible for either a standing or sitting passenger to tell by the motion of the train, with his eyes shut, that there is a curve there at all. The lurching sensation in ordinary railway travel arises chiefly from the fact that the speed of no two trains are alike; and hence, it is not possible to adapt the elevation to them, and in part from the absence of transition spirals to connect the curves and tangents, which are only used in the best modern work. The elevation of outer rail required on the horse-shoe curve is 5⅝ ins., for 10 miles per hour.

It is also proposed, however, not from necessity, but for greater economy and convenience, to further facilitate the operation of these horse-shoe curves by laying a broad outside rail having a trough or broad flat groove coated with a thick grease, and to provide the wheels on one side of each axle, with a broad flat flange resembling a narrow duplicate tread, which rides in the bottom of this groove, and is of an outside diameter to correspond to the difference of radius of the outside and inside rail.

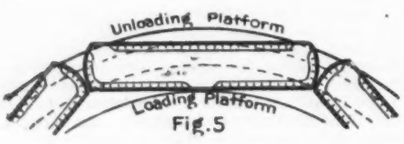

Fig. 5

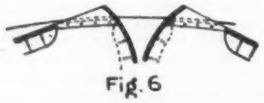
Fig. 6

Arrangement of Car Exits and Entrances.

This gives in effect an outside larger wheel used on the sharp curve only, which carries the main tread of the wheel on which the brake-shoes act, clear of the grease. The curve resistance, and extra rail wear as well, will be in this way almost entirely eliminated. What remains will be of no serious moment.

THE CARS AND PLATFORMS.

The cars which stand on the horse-shoe curve have their ends thrown far away from the loading platform, as shown in Fig. 5; so far away (4 or 5 ft.) that with ordinary end-platform cars and very numerous trains it would hardly be feasible to load and unload on the curve at all.

The most essential feature of the present plan is the arrangement of car doors, by which it is made indifferent whether the cars stand on curve or tangents for either loading or unloading, which is as follows (see Fig. 5):

The inside platform is used for loading, or for outgoing passengers, only. *The middle* of every car, as will be seen by the sketch, is always adjacent to this platform, whether on curves or tangents. A central door is accordingly placed on this side, used for entrance only. The end doors or end-platform gates on this side of the car are permanently closed, if the car has any, as worse than useless.

The outside platform is used for exit only, and on this side *the ends* of the car are always in contact with the platform, whether on straight line or on the curve. Doors or platform gates on this side are placed accordingly at the ends only, from which exit only is permitted.*

The effect is not only to make the horse-shoe platform as useful as the straight for loading and unloading, and to increase the seating capacity of the same car floor space from 42 to 56 or more, but also to very greatly facilitate rapid loading and unloading.

The passenger entering through the middle door, knowing that he can only leave through the end doors, goes as near to the end of the car as possible, thus leaving the way clear behind him for others. As a loaded train enters the station the passengers naturally gather around the end exit doors, leaving a clear open space for incoming passengers to enter. When the doors are simultaneously thrown open, the stream of incoming passengers, so far from impeding the exit, serves as a substitute for the brakeman to quickly drive out the laggards.

It cannot be doubted that cars arranged in this way will both load and unload more quickly than either process can be done separately, for the reason that the passengers are in no case in each other's way, but keep always moving ahead out of the way of those behind. In other words, no passenger ever has occasion to go back upon his tracks within the car to get out again, and so interfere with others.

In trains of this length there will be a natural tendency among the passengers to select a location in accordance with their destination. Those going to Broadway or west of it will take the middle cars. Those going back towards the East River will take the end cars, and so on. Thus there will be a constant tendency to utilize all parts of the ample platform space. A difficulty which may have to be guarded against, however, will be a tendency of the south arm of the horse-shoe station to receive more passengers than the north. A means of avoiding this which would be exceedingly popular will be to make the rear four or five cars of every train smoking cars, and permit smoking on the north platforms.

With such ample station arrangements as proposed this is feasible. With the present arrangements it is not feasible, and many passengers are lost to the bridge and gained by the ferries because of the fact that they can smoke on the one and not on the other.

End doors to connect the cars may be used or not. It is doubtful if they serve as useful a purpose as would the four seats per car which they destroy. The end doors are little used on the elevated trains, and that little is mostly from mere restlessness. With these still shorter trips the seating space will be worth more.

Fourteen-car trains will be 10 cars, or 33 seconds, longer than the 4-car trains which it is now proposed to run at 90 second intervals. Allowing only 3 seconds to be saved by the superior method of loading and unloading, they can be run at two-minute intervals with the same safety distance between trains as now, giving a car capacity of $30 \times 14 = 420$ cars per hour, and *seating* capacity of $420 \times 56 = 23{,}520$ passengers per hour. By running 18-car trains (see Fig. 7) given last week at 2 minute 20 second intervals, a capacity of 468 cars or 26,208 seated passengers per hour will be obtained, but this may be taken as the utmost possible over a single roadbed and track. The *total* seating and standing capacity of the present 3-car trains, with 100 passengers crowded into cars seating only 42, is 12,000 per hour, which will be increased by the approaching addition of another car to 16,000 per hour, and it is probably doubted by no one that these 4-car trains will be at once crowded as full as the 3 car trains now are.

These figures place it beyond all reasonable doubt, without entering into any niceties of calculation as to the exact probabilities, that the available *seating* capacity of the long trains here proposed will be almost immediately used up in regular every-day service, without considering the traffic of extra heavy days. The only remaining possibility for meeting the inevitable future growth of traffic, will then be to begin anew the process of overcrowding the cars, which should never be permitted while other possibilities remain. For expenses will increase in far less than direct proportion to the number of cars. Up to the limit of the total car-moving capacity herein provided for, careful computations, which the writer will be pleased to give in detail, and which allow fully for all direct and indirect expenses, indicate that the extra cost of seating every passenger, even in the rush hours, instead of packing them in like cattle, will not (at least, need not) exceed one-fourth cent. per *additional* seated passenger who would otherwise ride standing, leaving the cost per passenger now seated unchanged.

As a mere money-making investment to increase the traffic of the bridge this slight increase of expense would be advisable, apart from the equitable claim of every passenger to a seat when it can be had at so slight a cost. Nothing could be a a more attractive novelty, or tend more powerfully to attract residents to Brooklyn by contrast, than to be able to secure seats even in the crowded hours. And it may be added that nothing could conduce more to the public interest than for the cities of New York and Brooklyn to demonstrate on the only line under their control that the shameful overcrowding which prevails on public conveyances comes chiefly from private greed, and is not a necessity of their profitable operation. In suburban train service, where the expenses are far greater in proportion to fare paid, such overcrowding is never thought of. But at present it comes with an ill grace for the public to complain, since the only line over which they have absolute control is the worst offender of all.

The question, therefore, is even now an urgent one, whether it is possible to still further increase the capacity of the bridge beyond 14 or 18-car trains over a single track. It appears probable that it can be doubled again, by adding a second story or deck cable track above the present one and entirely independent of it. If so, the obviously proper use for that track is for running cars from the various Brooklyn elevated lines *direct to the New York terminus without transhipment*, leaving the lower (present) track to accommodate the horse-car passengers and such others as come to it. With any other form of terminal station than that herein proposed this would be practically impossible, for lack of terminal room at New York. Under the circulating system, with such cars and stations as proposed, it is unquestionably entirely practicable, and at very moderate cost.

This upper track is the more likely to be early demanded because it will provide not simply more facilities, but *a different and better* KIND *of facilities*, than any heretofore in use or, so far as the writer knows, suggested. If constructed, it would give a total capacity of about 900 cars per hour, or just 7½ times the present capacity, with 3 car trains. The means of access from the street to the station, as below sketched, will be from fifteen to twenty times as great as now, at least; the interior means of access to the cars will likewise be ample; the architectural effect of the station will be decidedly improved by the additional height required. There remains therefore only the question of adapting the bridge to such an upper track.

A SECOND STORY CABLE TRACK.

The question of the capacity of the bridge to carry one or more additional pairs of cable car tracks is one of too purely technical a nature to be advantageously entered into in this report. Suffice it to say that the writer has given the matter some study, and has taken the opinion of one of the

* A minor difficulty will be seen from Fig. 5, that the corner of the car is not exactly parallel with the outside platform at the ends, as the center door is with the inside platform: but must either project over the platform or leave a slight triangular gap to be stepped over. This difficulty is overcome by the simple device shown in Fig. 6; viz., chamfering off the under part of the corner of the car, and adding a boiler-plate extension faced with rubber, which rides over the platform.

most competent and expert bridge engineers in the country for this class of structures, who is familiar with the construction of the Brooklyn bridge. He therefore deems it an entirely safe statement that from $150,000 to $500,000 will suffice to make all necessary changes in the suspended superstructure to add a second track above the present one, and that for less than $1,000,000 two extra complete track circuits can be added to the bridge, one over the present cable tracks and one over the outer roadway.

This is on the assumption that only minor reconstructions of the floor system, stiffening trusses and tower stays will be required to provide amply for the trifling percentage of increased load on the cables, as is believed to be the case; but even if more considerable modifications are required, the *total* cost of the suspended superstructure, cables and all, was under $3,500,000 (out of about $14,500,000), and it could probably be renewed complete to-day for considerably less than that sum. Fortunately the type of structure is such as to permit of such strengthening without entire reconstruction more readily than most others.

These figures will show that the cost of gaining the additional capacity can in no case be a serious matter compared with the benefit derived.

In case both of these upper circuits were added, the outer one would rise above the inner one at the termini, and enter the buildings on an additional upper floor. The entire practicability of taking the crowd of passengers to and from such upper floors, by powerful and capacious lifts, has already been demonstrated at Liverpool and elsewhere, and will not be questioned.

The upper track or tracks can be readily operated as follows:

A separate grip car, provided with powerful grips, should be used in lieu of a locomotive. It is a mere question of proportion to get any desired gripping power.

Successive trains as they arrive from any quarter of Brooklyn should be coupled on to this car, locomotive and all. The locomotives may use a little steam going up grade on the bridge, but otherwise pass over simply as vehicles, to save the trouble and delay of cutting them off.

Promptly on time, whatever the number of cars, the cable train should leave, discharging its passengers at New York, taking a fresh load and returning to the Brooklyn terminus, where the grip car should drop by gravity around the horse-shoe to its position for the return trip, and the train behind it be cut up into its original constituent units for the several lines.*

It is not recommended that both these upper circuits, nor possibly either of them, should be immediately constructed, but before the end of the present century both of them are likely to be needed, and hence the ultimate construction of both should be provided for in all present plans; and it is believed that one complete circuit for the direct service should be added at once, for the following reasons:

Within the belt which is more than 2 miles and less than 8 miles from the New York City Hall, there is about 7¼ times as great an available residence area in Brooklyn as on Manhattan Island, as shown on the map given last week, measuring the Brooklyn distances *via* the bridge and Brooklyn City Hall, and not in an air line. Balancing the New York horse-car travel into the business section against the Brooklyn ferry travel, and neglecting both (both having about the same volume; and coming chiefly from a narrow belt near to the business section), there are 150,000,000 passengers coming from upper New York to *down-town* New York (below 14th Street), *via* the elevated lines, against only 30,000,000 from Brooklyn *via* the bridge. Were the Brooklyn areas at equal distances sending as much travel to down-town New York as the Manhattan Island areas, there would be $150,000,000 \times 7\frac{1}{4} = 1,087,500,000$ passengers per annum over the bridge instead of 30,000,000, or 36 times as much as now. While this enormous aggregate can never be expected, the computation does indicate the fearful disadvantage under which Brooklyn labors from the lack of foresight of its citizens and property holders in not having, long ere this, exhausted the resources of engineering to place it strictly on a par with up-town New York in transit facilities, as by this plan at least it is readily in their power to do at trifling cost; the passenger being carried without change from any point in Brooklyn to the New York City Hall, as from any point in New York.

The advantage and stimulus which such direct transit would give to Brooklyn as a residence city can hardly be exaggerated. It is not too much to say that it would entirely change the character of many parts of it in that respect. In the judgment of various experienced real-estate men whom the writer has consulted, it would at once add from 10 to 25 per cent. to the renting value of Brooklyn residences, according to their distance from the City Hall; and fully $100,000,000 to the present assessed valuation of $383,000,000 within a very short time after the whole improvement had been carried out in thoroughly good shape.

The advantage must not be gauged by what can be figured out as the bare saving to the passengers of time and muscular exertion, or even the possible loss of a seat. Experience has clearly shown that the disadvantage of changing conveyances *en route* is much greater than can be accounted for in this way. The fact seems to be that in every family there are young, infirm or timid members who have a dread of such changes, and the movements of the whole family are governed by those who perhaps do an insignificant fraction of its traveling. At any rate, even a single change between cars on parallel tracks on long railway trips is found to have a serious effect on patronage. In rapid transit trips it is proportionally a vastly greater objection, and has likewise a vastly more serious effect, since it decides the choice of a residence instead of a route for a single trip.

To the poor of New York such facilities would be of especial value, since it would give them direct and quick access to the cheap lands and homes of surburban Brooklyn, which are now beyond their reach because of the time and cost of getting to them.

Direct pecuniary advantages to the revenue of the bridge would also result from the immediate construction of the upper track, as follows:

First. It would save the cost of operating the lower (present) tracks during the unprofitable night hours. The Brooklyn Elevated trains must run at night anyway, and they could be run over the bridge by their own motors during the night, with greater profit to them as well as to the bridge. At least $30,000 per year should thus be saved.

Secondly. An enormous summer business by direct trains from the New York terminus to Coney Island and other Long Island resorts can be done without any extra car service or expense, leaving the revenue from it clear gain, since it is in the reverse direction from the rush of business travel, *viz.*, from New York in the morning, and back to it at night. After the opening of the Brooklyn Elevated lines now building, there will be four different routes by which such transit will be possible, and more will be added. This traffic should fully double the bridge's *net* earnings during the summer months, or be worth to it from $250,000 to $400,000 per year.

Thirdly. The direct transit, in connection with a new Elm Street and Fourth Avenue line, would greatly stimulate the shopping, calling, theater and other transient travel between New York and Brooklyn, which is also highly profitable, since it is mostly off-hour traffic. As will be seen below and in Fig. 2, it is proposed to provide both the Manhattan Elevated and the new underground Elm Street line with termini within the building. The indirect value to Brooklyn of providing well for this traffic is not to be measured by the mere bridge fares collected. As upper New York will always be the chief shopping, social and theater center of the metropolis, Brooklyn's future as a residence city depends on making a trip to it a pleasure and not a burden, even more than on quick business transit.

Supposing eight Brooklyn rapid transit lines to be delivering 4-car trains at 3-minute intervals there will be $8 \times 4 \times 20 = 640$ cars per hour to take care of. A single track circuit will permit of about 14-car trains at 2-minute intervals or 420 cars per hour, or would give direct transit to about five lines only, which are now building. When, and if, this capacity proves too small (it is equivalent to about 150,000,000 passengers per annum, or about that now entering lower New York, *via* the four Manhattan Elevated lines) the second outer circuit must be added, but one will certainly suffice for many years.

THE BROOKLYN TERMINUS.

Under the system of operation here outlined there is but one rational and defensible location for the Brooklyn terminus, viz., *precisely where it is*, but on the axis of the bridge prolonged (see Fig. 7, given last week,) the center of the rotunda being exactly on the center line of Washington Street, a little below Sands Street.

Architectural dignity and propriety indicate this to be the proper course, as well as more urgent reasons, the twist in the bridge approach at the Brooklyn end being an unsightly feature.

This requires the acquisition of most or all of the small and cheap block between Washington and Adams Street, opposite the present building. The two locations for a terminus at the City Hall or at Concord Street, over which there has been so much dispute, become alike inadmissible under the plans here outlined, but the land now owned in that direction will all be useful and necessary for storing the rush-hour cars during the off hours.

The necessity for retaining the station where it is results from the configuration of the streets at that point, and from their relation to the bridge axis. It is proposed to leave Washington Street entirely unobstructed as a foot, team and horse-car approach to the bridge, and to provide for four elevated lines each in Fulton Street and Adams Street, as follows:

In each street there should be placed two tiers of two tracks each; the upper tracks *both* up-tracks and the lower tracks *both* down-tracks, each track accommodating the trains of two lines.

Each line in succession branches off from the trunk with its up and down-track still in the same position, *i. e.*, one above the other, the two being brought into their normal position, side by side, as soon as possible thereafter, which may be within a block or two of the point of separation. All four lines of each main stem will probably have separated from each other not far beyond the City Hall.

The details of the arrangements thus briefly outlined work out very favorably at the bridge terminus and elsewhere. The consent of the lines which have now preëmpted Fulton and Adams Streets for their sole use can be enforced (if not freely given) by making it a condition of their running trains over the bridge.

The arrangement thus rudely outlined seems to be, and is, a peculiar one, but it is the only possible one to accomplish the end, and it is to be regretted that the people of Brooklyn do not more clearly perceive that their whole rapid transit problem is a peculiar one, compared with which that of New York is simplicity itself; and that by failing to act accordingly, they are greatly imperilling the symmetrical and healthy growth of their city.

The special difficulties are, *first*, that the rapid transit lines must radiate in fan-like fashion from a single point, for the first time in the history of engineering, and *secondly*, that from this point the traffic must be carried for over a mile over a single way of communication to an exterior point. There is no other city in the world where a similar problem has or can arise on any considerable scale.

The special difficulties all lie within a mile or so of the bridge terminus, but there they are very great, and they will be fatal to the healthy growth of Brooklyn unless plans are worked out as a whole with corresponding care, and with careful provision for the future as well as the present. By building another bridge, say at Grand Street, the difficulty may be in a sense diminished, by splitting it in half, but as the nature of each half remains the same, the necessary treatment of each half likewise remains the same.

The preceding suggestions appear to exhaust the possibilities of the bridge as respects car-carrying capacity. When they are exhausted, which will not be till some 400,000,000 passengers per annum are passing over the bridge, or some 250,000,000 if seating capacity only is counted; the only resource will be to build another bridge.

It remains only to consider the two phases of the problem which have been heretofore postponed: Access from the street to the station, and improvement in the architectural appearance and surroundings of the terminus.

* It may be arranged in a very simple way to run the cars only over the bridge, the locomotives dropping and resuming their trains on the Brooklyn side, but the above method seems the better one.

ACCESS FROM THE STREETS TO THE STATION.

This is really the weakest point of the present arrangements. It is proposed to increase the present facilities fully twenty-fold, by simple and inexpensive measures outlined below, so that a traffic ten times as great as now, as in time it may be, can be carried without half the jam in the street approaches. Three of the measures to this end are in a sense for architectural effect also, since they are demanded for that end alone. They may therefore be considered first.

MANHATTAN ELEVATED STATION.

The lower (present) bridge tracks being reconstructed on a decided down grade toward Chatham Street, so as to be only some 10 or 12 ft. above the street, by running in the upper bridge tracks (for the direct Brooklyn elevated service) *level*, or on a slight up-grade a mezzanine floor may be introduced at the Chatham Street end of the station on which a horse-shoe circuit terminal for the Manhattan elevated line may be introduced, giving that line corresponding advantages to what the bridge service gains from the new terminal, and dispensing with the present utterly inadequate and unsightly Chatham Street terminal, while affording the best possible connection between the New York and Brooklyn lines.

BRIDGE ACROSS PARK ROW.

If the present unsightly Chatham Street station were removed from the immediate front of the bridge terminus, it would be much more apparent than now, that the present bridge across Park Row is quite unfitted architecturally, as well as otherwise, to remain in front of a terminal in which some respect was paid to appearances, especially as it butts against the dilapidated Registry building, which occupies, for the mere sake of saving rent, ground which should be given up to grass.

By removing this building (as Mayor Hewitt has proposed) and the present bridge, and erecting a light and graceful arch of the form outlined in Fig. 3, an open park front will be given to the station, and direct access to it obtained from Broadway, without going up or down a single step. This change alone will put a very different aspect on residence in Brooklyn for those doing business on the west side of Broadway, and add greatly to the attractiveness of City Hall Park, especially for this reason:

The present Registry building (which has been altered out of all resemblance of its former self) was a Revolutionary prison, and in it NATHAN HALE was confined on the night before his execution, which took place nearly under the bridge at Franklin Square. What more appropriate place than the site of this building, at the end of the bridge, could there be for erecting the statue to his memory, a suitable site for which is now in question? It would be about midway between the bridge terminus and City Hall Park, and the statue, bridge and the two buildings would then help out each other, while a suitable inscription would keep in memory not only the man himself, but the spot on which he suffered imprisonment and death.

The archway should be at least 40 ft. wide, and better 50 ft., and should span sidewalks and all. All steps being eliminated it will accommodate easily four to six times as many as now use the bridge. It connects on a level with the exit platforms, and also with a ramp which passes down so as to barely pass under the track, giving a headway for the distance between the rails of about 7 ft. The passage-way then rises by a ramp (or a few steps might be preferable) into the central rotunda. Only for the 5 ft. under the rails would the headway be contracted.

ARCHES OVER ENTRANCE TO BRIDGE ROADWAYS.

For the mere sake of architectural propriety the roadways of so grand a structure should terminate in some feature like an entrance arch carrying a handsome iron gate, like that of the Mills Building, instead of rough wooden gates. Such arches would also serve a practical purpose in connection with a side stairway of stone to give access to the station without crossing the roadways, under either of the plans outlined in Figs. 1 or 2, and are provided for in each.

STREET CAR CIRCLE.

So much headway as now exists beneath the cable-car tracks, now used for the promenade and waiting and ticket rooms, will be no longer needed. The tracks may therefore be dropped somewhat and still leave a great deal of space below, which may be utilized in a highly advantageous way to make a circular terminus for street car tracks beneath the rotunda and connecting therewith. The Broadway, Chambers Street, 3d and 4th Avenue, Elm Street and other lines, could use this terminus for a certain number of their cars, thus enabling Brooklyn passengers to enter and leave New York horse-cars under cover in the same building, while relieving lower Park Row. There will also be sufficient space for a cab-stand as well, under cover.

ENTRANCES FROM NORTH WILLIAM, WILLIAM AND ROSE STREETS.

These streets have heretofore added nothing to the approach facilities, for the good reason that there was no possible chance above to give the necessary floor space to permit of stairway or elevator connections with them. The new terminus will permit all three streets to be utilized in this way on an extensive scale, and it is expected that a large part of the total traffic will enter through them. As will be seen in Fig. 2, the entire length of all four sides of the building is utilized for entrances.

A glance at the map will show how greatly these new entrances will tend to increase the area tributary to the bridge at the expense of the ferries and up-town New York, while affording necessary and great relief to Nassau Street and Park Row. This will be still more clearly seen if we remember that as a natural effect of propinquity and past conditions the greatest proportion of Brooklyn residents doing business in New York are located along the East river, the proportion increasing westwardly, so that west of Broadway there are comparatively few. Probably a large majority of the bridge patrons are now compelled to go west first, to the very west end of the structure, before they can go east, so that they have to go out of their way to get into a crowd.

The same fact also suggests that a still greater and more generally useful increase in means of access to the bridge can be obtained through the promenade, as follows:

THE PROMENADE.

Simultaneously with the construction of an upper track it is proposed to prolong the grade of the high part of the promenade (beyond the anchorage) backward without a break to the rotunda, which it will just strike, taking out the present promenade stairway at the anchorage and giving an upper promenade parallel with the present one and about ten feet about it.

This change not only eliminates the stairway, which is an objectionable and even dangerous feature, and caused the only serious accident in the history of the bridge, but leaves a vacant section of the old promenade underneath the new one which will be well adapted for running elevators up into it from the streets below; at first only from Franklin Square and near the river front, but adding to them as traffic warrants. To run them up into the main promenade would be so unsightly and even dangerous as to be practically out of the question, but narrow stairways may give access to the main promenade from the lower one.

This will afford an independent approach from the eastward streets to the cable cars, preferably collecting the car fare before the elevators are entered, and then connecting the lower promenade with the outgoing platforms direct, without further ticket wickets, making no extra charge for using the elevators. Those ascending the elevators merely to reach the main promenade will then pay a cable-car fare. There will thus be in the crowded hours two opposite streams of passengers on the two promenades, those on the upper one walking over to Brooklyn and those on the lower one walking down toward the New York terminus to take the cable cars.

A large part of the receipts thus gained will be clear gain, so that the elevators will unquestionably pay for the cost to run them directly, while the indirect gain to the bridge traffic and to public convenience will probably be found to be surprisingly great, especially if one or more similar elevators were added on the Brooklyn side. For example, it will be the easiest way to reach Broadway from the East river front, even if one does not wish to cross the bridge at all.

The disadvantage the bridge cars and promenade are under now may be paralleled by comparing the traffic a street car line would have which admitted passengers at the termini only, with that of a line which admits them at all points. It is not possible to admit passengers to the cable cars except at the terminus, but it is possible by this plan to admit them to a shaded, comfortable promenade by which they can walk *down-hill* to the cars.*

STREET CARS OVER ROADWAYS.

The spaciousness of the New York terminus makes possible still one more improvement in transit facilities, viz: to utilize the vacant space under the New York terminus to enable horse cars from Brooklyn as well as from New York to turn into it under cover and return, thus bringing New York and Brooklyn street cars into direct connection under cover.

Heretofore the lack of terminal room at New York, if nothing else, has made it impossible to allow Brooklyn street cars over the roadways of the Bridge. By admitting them to the roadways, two street car fares will enable one to pass from any point on Broadway or the Bowery to any point in Brooklyn, by practically a single trip. It appears probable also, that the elevators to the promenade just suggested could be so arranged as to give direct access from them to the horse cars, without the slightest injury to the appearance of the structure, which is the only obstacle. The opportunity would no doubt be eagerly availed of by the street car lines at a considerable toll, as the longer haul would be balanced by doing away with the long, steep grade from Fulton Ferry.

The rail should be a flat bar, flush with the planking, having a groove in it just wide enough to admit the flange, similar to the "Liverpool rail" used throughout England, but as yet almost unknown here, which offers no obstacle whavever to wheeled vehicles.

The additional traffic thus gained would be largely supplemental to that in the cable cars, and not drawn therefrom, but rather from the promenade. It would at least be expedient in planning the new station to plan it so as to afford these facilities, when desired, in the best manner, without further modification. The date when the street car tracks were to be laid could then be left in abeyance.

STREET CARS AT BROOKLYN TERMINUS.

The space beneath the rotunda of the Brooklyn terminus is far more imperatively needed than that at New York as a terminus for street cars, and will be much more commodious than the present open space at Fulton Ferry. At present the street car arrangements at the bridge are very contracted and inadequate, and for this reason, and because the present bridge traffic is relatively so small, rather than from the preference of the companies (who would naturally prefer to save the steep haul from the ferries) the service of cars running directly to the bridge is scant and unreliable, thus driving many passengers from the bridge to the ferries in order to obtain seats in horse cars on the Brooklyn side.

In view of the great importance to Brooklyn of making the transit to New York as attractive and comfortable as possible, and of the present crowding it is believed that all the facilities herein outlined, except the third cable track circuit, will be none too great for advantageous early use, and will be cheap indeed at their probable cost, which is rudely estimated at $1,000,000 for the single track complete, chiefly for the two terminal buildings at each end of the bridge, and the ground they stand on, and between $1,000,000 and $2,000,000 more for the overhead tracks connecting direct, without change of cars, with all the elevated lines. There will also be not the slightest difficulty in executing all the works complete without any interruption whatever of regular traffic.

Summarizing the ground gone over, the system of operation herein suggested is believed to offer the following advantages as compared with any others

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*A stretch beyond the anchorage and stairway, toward the river, where this sub-promenade might be desirable, is now blocked by tie-rods under the high promenade. By substituting stiffening knees or angles this space also will become available. It is worthy of note, also, that an elevator trestle to connect the river front with the middle point of the anchorage span (between the anchorage and the tower) will serve a useful purpose in stiffening the bridge against vibration and undulation, since at that point the bending moments are the greatest of the entire structure.

which have been or (for the most part) can be suggested:

SUMMARY OF ADVANTAGES:

As respects Requirement A; Car Carrying Capacity:

1. It affords the maximum capacity for the present cable tracks; about three times what is reasonably practicable by any other plan whatsoever.

2. It affords the only reasonable possibility of enlarging the capacity by one or two additional cable circuits, which is impossible without effective terminal arrangements.

3. It is the safest possible plan; there is not a frog or switch in the track in regular use, tail collisions only are possible, and the speed never varies from 10 miles per hour.

4. *It saves all expense and room for switching and switching engines,* and for interlocking apparatus, which alone more than pays interest on the whole cost of the improvement.

5. *It saves a large sum annually in train-wages* making each trainman five or six times as efficient.

6. It gives longer haul, taking passengers more nearly to their destination.

7. It requires four full trains less to be in service for the same capacity than would be required by a switching system, or 7 in place of 11. With 18-car trains, at $3,500 per car, this represents a saving in capital investment of $252,000.

8. It enables every passenger to be provided with a seat, for the present at least, even in crowded hours, and enables the crowd on exceptional days to be readily handled.

9. It enables smoking to be permitted in rear cars without danger of annoyance to non-smokers.

10. *It affords the only possible chance for a direct Brooklyn elevated train service terminating in New York* which will alone return to Brooklyn a hundred-fold the cost of the improvements.

11. It will especially benefit the poor of New York, by giving them ready access to the cheap homes of suburban Brooklyn; and makes possible a lucrative off-hour traffic to Coney Island and elsewhere, which will be nearly clear gain to the bridge revenues.

As respects Requirement B; Interior means of access to cars.

12. It provides a broad, spacious rotunda, with ample connected floor spaces to the east, all open to the public without delay at ticket booths, in which a large crowd can spread itself and prepare at leisure to enter the cars. In this way also:

13. It affords direct access *from the side* to and from all points of the train, with room for any number of ticket gates, instead of giving access at the end of a long platform only.

14. It promotes quick loading and unloading o cars, and enabling both processes to go on at once by a more rational arrangement of car entrances.

15. It provides ample space for waiting and parcels rooms, news stands, toilet rooms, refreshment and cigar stands, and similar public conveniences, now lacking.

As respects Requirement C; Means of access from the city streets to the station.

16. It gives direct access to the bridge from every street which it crosses, or from as many as may seem desirable, through a new sub-promenade.

17. It utilizes the three streets which the terminus stands over as approaches, and so relieves Park Row and Nassau Street, throwing most of the travel into these less frequented neighboring streets; while at the same time:

18. It reduces the average walk to the station, and greatly increases the number who can use the bridge to advantage.

19. It gives communication by a direct path with Broadway without steps, and eliminates all stairways at the Brooklyn terminus.

20. It gives both the Manhattan Elevated Railway and the proposed underground Elm Street line ample terminals within the building in direct connection with the bridge cars and trains of the Brooklyn Elevated Railways.

21. It provides archways over the bridge roadway entrances, so that the station can be entered and left without crossing the roadways on a level.

22. It eliminates the promenade stairway, which caused the only serious accident on the bridge, while giving through the promenade new and more convenient access to the cars.

23. It gives with the New York and Brooklyn street cars needed and commodious terminal stations in direct connection with the bridge cars.

24. It gives Brooklyn street cars the only possible chance to run over the bridge roadways and connect with the New York street cars direct.

As respects Requirement D; Architectural dignity and appropriateness:

25. It provides stately and spacious buildings, worthy of the bridge and the location, which will do honor to both cities, in place of the present unsightly agglomerations, which are a reproach and disgrace to both cities, and create a reasonable suspicion that they are without either good taste or good sense.

26. It improves architecturally the present Manhattan Elevated station, the present bridge over Chatham Street, and the entrance to the bridge roadways by changes which are useful as well as ornamental.

27. In these and other ways it sets an example of good service instead of bad service to the people and to other transit companies, which will be likely to bear fruit in more or less general improvement in the lines controlled by private interests.

28. As a combined effect of all the preceding it should enormously increase the bridge revenue, both from the promenade, roadways and cable-cars, and tend powerfully to promote the growth of Brooklyn, in both population and wealth, by eliminating its greatest disadvantage as a residence city.

All of which is respectfully submitted.

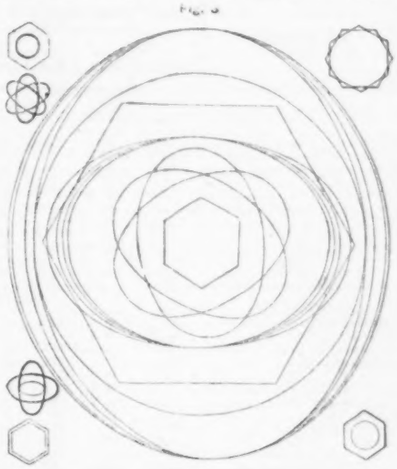
A. M. WELLINGTON.

TRIBUNE BUILDING,
New York, Dec. 8, 1887.

Bennett's Geometric Compasses.

A pair of compasses is described by London *Engineering* which will describe any figure as a circle. The main principle of the invention, as indicated by Fig. 1, is the use of a stationary leg and foot D; a template, or model of the figure required, A, being placed upon it, around which the central leg B revolves, kept in its place by a spring in the joint so

directing the pen in its course as it draws the figure. The value of the instrument is increased by the fact that it can not only draw a perfect counterpart of any one template, but an almost infinite number of variations from the same model. For instance, if the slide A be elevated, the ellipse is necessarily elongated, or correspondingly shortened if the slide be lowered. Or if the pen be extended, by means of quadrant C, the ellipse becomes enlarged at both major and minor axes; so that ellipses of any required diameter may be drawn by a perfectly simple mechanical process, and as freely as circles are described by an ordinary compass. Again, in the drawing of a hexagon, or other polygon, great variations of the same figure may be obtained by similar means. And the results are not only that the sides of the figure may be drawn perfectly straight, but



either concave or convex as the draughtsman may desire, by elevating or lowering the template, the pen being placed at the point of required circumference. Further, on replacing the foot D by a special point supplied for the purpose, the instrument becomes an ordinary compass for the drawing of circles, etc. The principles involved in the working of the small-bow compass, Fig. 2, will be self-evident from the illustration. The pen may be set to size, and hexagons produced of any required diameter within the limits of the compass. Fig. 3, gives an idea of the work achievable by these instruments, the small figures at the corners being drawn by the bow compass. An instrument which will easily and rapidly produce any required ellipse or polygon, of whatever axes, has long been much wanted, and much interest has been shown in it by professional draughtsmen, artists, designers, and architects. It is manufactured by Messrs. J. F. BENNETT & Co., Sheffield, England.

AN ingenious "power scale" (the Emerson) for determining the amount of power transmitted by belt or otherwise from one shaft to another, or from engine to shaft, or for determining the amount of power that an engine is capable of developing, or the amount of power required to drive any machine, has recently been brought out by Fairbanks & Co. The force or power transmitted is actually weighed by this scale as a load of coal or a barrel of sugar is weighed by the ordinary platform scale. It is in substance a regular compound lever scale, and may be attached to any size of shaft, the same as a split pulley. It seems to be one of the best and most practicable forms of dynamometer which has ever been devised. It does not destroy the power measured, like the Prony brake; but simply, in effect, measures the static moment of the force transmitted, which when multiplied by the number of revolutions gives the horse-power at once.

Engineering, of March 9, contains plans and photographs of the falseworks erected on the banks of the Thames for testing the accuracy of workmanship in the cantilever bridge, then building for the Sukkur crossing of the Indus river. The writer of the article, Mr. WM. PARSLEY, C. E., defends this temporary erection in England by the statement that the design was novel, and that "after the experience of carrying out the work he is convinced that no certainty could have been secured of the parts being complete and their fitting together unless the bridge had been first erected in the contractors works." This is rather severe on the contractors for the iron work.

Tramp—Say, Mister, gi'me tin cents, will yer? I wanter git a drink. High License Citizen—Drink water. Tramp—That's just it, boss. I want ther tin cints ter buy a filter, so's I kin swaller ther water.—*Philadelphia Call.*

The Weather of the United States for the Month of February, 1888.

[As respects the elements of most interest to engineers.]

According to special returns from the Chief Signal Officer of the U. S. Army.

STATION.	Temperature. Degrees Fah.				Wind Velocity. Miles per hour.			Precipitation. Rain and melted snow. Inches.		
	Average	Max.	Min.	Range.	Average	Max.	Direction. Max.	Total.	Heaviest in 24 hours.	No. rain days.
Northern Cities.										
Northfield, Vt.	16	45·5	−23·3	68.8	9.2	48	S	2·73	0.75	17
Portland, Me.	23.2	43·9	− 7	50.9	6	28	NW & SE	5·40	2.25	11
New York City.	31.6	54·8	3	51.8	9.3	38	W	4·03	1.80	11
Pittsburg, Pa.	34.1	61	1·1	59.9	7.4	28	SE	1·74	0.63	15
Chicago, Ill.	23	47·2	−17·5	64.7	11.1	45	S & SW	1·51	0.76	9
Omaha, Neb.	25.9	62·5	−17	79.5	8.3	42	N	0·74	0.59	2
St. Paul, Minn.	12.4	44·1	−33	77.1	6.8	28	W	0·64	0.25	12
Duluth, Minn.	12	50	−32·5	82.5	6.5	40	NW	0·24	0.12	11
Bismarck, Dak.	10.7	45·6	−31	76.6	9.1	51	NW	0·44	0.13	12
Average	21	50.5	−17.5	68	8	38.7		1.94	0.81	11
Southern Cities.										
Washington City.	36	61	13	48	5	30	NW	3·19	1·13	13
Louisville, Ky.	37.9	66·8	8	51.8	8.9	36	S	2·56	0·68	16
St. Louis, Mo.	32.2	62·8	−3·5	66.3	10.8	48	SW	2·39	1·36	9
Savannah, Ga.	55.2	72	27	45	6.8	24	EWN	3·42	1·10	11
Leavenworth, Kan.	31.4	62·4	−5	67.4	7.6	28	NW	1·24	0·59	6
Jacksonville, Fla.	60.2	81·7	32·5	49.2	6.8	33	SW	4·38	1·32	13
Chattanooga, Tenn.	46.8	68·1	10·1	58.1	6.3	31	NW	4·92	1·67	12
New Orleans, La.	58.6	78·7	35	43.7	7	26	W & NW	11·21	4·21	13
Memphis, Tenn.	44	71	21	50	7.7	36	W	2·49	1·17	11
Palestine, Tex.	52.3	75	33·3	41.7	9.2	32	S	4·74	1·41	11
Average	45.5	69.5	17.1	52.4	7.6	32.4		4.05	1.46	11
Far Western Cities.										
Helena, Mont.	35	56	−1	57	9.7	50	SW	·12	0·07	8
Fort Angeles, W. T.	40·5	51·9	28·8	23.1	2.7	18	W	1·58	0·56	18
San Francisco, Cal.	52·8	76·3	41·9	34.4	5.3	25	W	0·94	0·38	5
Salt Lake City, U.	38.5	58.7	23·5	35.2	4.6	28	E	1·22	0·38	7
Denver, Col.	38·6	70·5	15·5	54.5	6.4	35	N	0·37	0·26	5
Yuma, Ariz.	60·4	84·8	39	45.8	7	36	W	0·05	0·05	1
Santa Fé, N. M.	35·5	55	16	39	6.6	27	N	0·90	0·52	8
Average	43.0	64.7	23·4	41.3	6.0	31.3		0.60	0.32	7

The Proposed Bureau of Harbors and Water-Ways.

From the advance sheets of a pamphlet setting forth the history and purpose of, and the work already accomplished by the Council of Engineering Societies on National Public Works, we make the following abstract, with the earnest hope that good may result to the engineering profession from the unselfish and earnest labors of the several members of the Council:—

Without going into detail it is sufficient to say that on Dec. 3, 1885, delegates from ten civil engineering societies met at Cleveland, Ohio, to discuss ways and means for bringing about a thoroughly organized system of conducting internal improvements in the United States. A permanent Board was elected, and on March 31, 1886, the delegates again met and effected a permanent organization under the title of the Council of Engineering Societies on National Public Works. This action was sanctioned, and delegates sent by 27 societies of civil engineers and surveyors, representing 2,680 members. All the work that has been accomplished since the date last mentioned, has been that of the Executive Board of the Council referred to, Messrs. L. E. COOLEY, J. EISENMANN, E. L. CORTHELL, LOUIS J. BARBOT and AUGUSTUS KURTH.

The first work of this board was the careful study of the public works organization of France and Prussia, upon which all other European systems are practically based. Great Britain is without such an organization, in the Continental sense; but in India, where the engineering problems are general rather than local, as in England, a full organization has been provided.

On the Continent all public improvements have been regarded as the province of the State; State schools were established for thorough education in all technical matters of public utility, and these schools supplied the personnel of the technical service, and also for general practice. The dangerous feature in this system was a high theoretic education without a properly balancing practical experience, and in recent years the tendency has been to combine the two. While engineers engaged on private works are still mainly recruited from the State schools, the increase in the industrial development has brought into service outside engineering effort. Promotions in the service are partly by merit, and partly by seniority. In England the system of pupilage under practising engineers was depended upon almost entirely for the education of engineers prior to the Exhibition of 1867, but the tendency now lies in the direction of a preliminary theoretic education.

Excepting the military, naval and purely government work, usually supervised by the Royal Engineers, the public works of Great Britain are in the hands of local harbor boards, which are trusts or corporations receiving harbor dues or aided by subventions from the government. There are no public civil works, in the sense understood on the Continent and in the United States. The English system was closely followed in our own country at an early day; but as the area to be covered was enormous and the distances great, the States stepped in and controlled public works until the railway era developed corporate and individual effort. In the early history of our canals and railways, West Point furnished a number of able civil engineers; though the great bulk of this and municipal work has been done by civilians. Our government has not patronized engineering schools, and since the establishment of the school at Troy, in 1824, private schools have supplied the vast body of engineers who have recognized standing. The United States is practically the only nation employing military engineers on its civil public works.

The report then goes on to outline the legislation proposed. After digesting a mass of material collected, the Board had an audience with President CLEVELAND on Nov. 11, 1887; was well received and its mission given earnest attention. After this the matter was placed in the hands of Hon. C. R. BRECKENRIDGE, and the bill introduced in the Senate on Jan. 16, 1888, which we gave in abstract in our issue of Feb. 18.

This bill has been widely circulated and commented upon, and the Board defends the retention of the bureau in the War Department and their reasons for not attempting a general reform of the government technical bureaus by advocating a Department of Public Works, as follows:

The incongruous departmental assignment of the several technical bureaus, and their lack of harmony and unity of purpose were recognized by the Board, as well as the desirability of systematizing the work of these bureaus. But for over two years (1884-86) a joint committee of Congress took voluminous and valuable testimony and considered this very work of reform without reaching important conclusions, only changes of minor import were suggested. The members of this Council were busy men with but limited time to devote to the end in question, and on mature deliberation it was concluded to restrict the present effort to a Bureau of Harbors and Waterways, as the most important and complex of a future department and the establishment of which would serve as a nucleus about which the others could grow in time. It was deemed expedient to retain this bureau in the War Department until the creation of a new department would be justified by further action of various scientific bodies concerning the bureaus with which they are more intimately connected and acquainted. An expanding organization, as suggested by some, which would cover any technical business the Government might enter upon, as telegraphs and railways, would in a measure continue the evils of duplication of effort which characterize the present loose organization.

In theory, the bill presented specifically organizes the Bureau of Harbors and Waterways under the War Department. It is to be a civil bureau, preserving what experience has shown to be good, correcting its evils and engrafting such features as experience in commercial engineering and in foreign systems has shown to be desirable. All projects should reach the Legislature through the executive rather than originate with the legislator or with a committee; this is the characteristic of foreign organizations, and many have thought such a provision would be wise with us. But our fundamental law wisely forbids any abridgement of the right of petition; though it will be the duty of the new Corps to study and report upon the needs and requirement of the country.

The Council realizes that wise provisions for appointments and promotions are most difficult to define; and while promotion by seniority only is liable to drift into a nerveless, dead-level bureaucracy, selection through pressure of influence and personal preference carries far greater possibilities for evil. The ideal system would be based on brain and experience, competence and merit; the trouble is to formulate this. In the system outlined in the bill the Council tests for fitness and experience are required up to the grade of Division Engineer; above that grade tests can hardly be valuable, and promotion by seniority is probably as efficient and fair as any other.

While the matter relating to the initial establishment and detail of organization is interesting, space forbids its publication here. The last Official Register of employés in the civil, military and naval service of the United States is dated July 1, 1885; at that time there were 431 persons so employed at salaries ranging from $68.94 to $250 per month. Of this number 133 were civil engineers at a salary of from $165.35 to $250 per month; and 69 were on the engineering staff as hydrographers, topographers, draughtsmen, transit and level men at corresponding rates of pay. The Council notes that in this year (1885) only 147 of the 304 works appropriated for were in operation. The average number of employés of the above named grades for a complete fiscal year is estimated at 153 civil engineers, and other engineering assistants at 150, or 303 in all. These lists do not include agents, superintendents, inspectors, overseers, etc.: including these in the yearly estimate, the total number would be 643, with a total annual pay roll of $904,480. In the same year there were 70 officers of the Corps of Engineers, U. S. A., on duty connected with civil works, and these received for the year $259,728.

PUBLICATIONS RECEIVED.

A Treatise on Plane Surveying. By DANIEL CARHART, C. E., Professor in the Western University of Pennsylvania. Boston, Ginn & Co., 1888. Price $2.00.

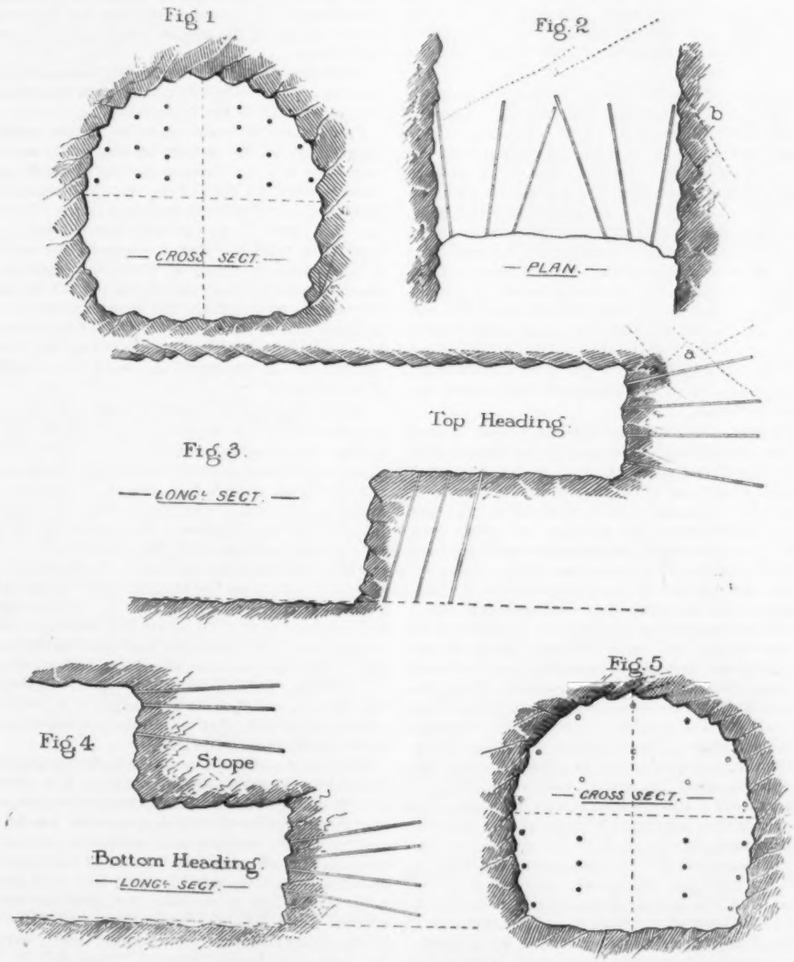
This neatly printed octavo volume, of 410 pages text, and 87 pages of tables, will, undoubtedly, prove useful in academies and classical institutions where the time devoted to the subject is only sufficient to allow a thorough course in compass surveying, with a brief smattering of other methods. The magnetic compass is now mostly a thing of the past, and yet nearly 300 pages are devoted to it in this treatise. Contour lines are now of some importance, yet the only reference to them in this book is about a page of incidental mention in the chapter on mine surveying. Five pages are devoted to the formulas for stadia measurements, but no information is given how to conduct a stadia survey. The solar compass is thoroughly described, and the instructions for the survey of public lands are set forth in detail. The work is fully illustrated with cuts of instruments borrowed from the catalogue of the manufacturers.

Bottom vs. Top Heading in Rock Tunnels.

BY C. L. KALMBACH.

Thirty or forty years ago all drilling was done by hand, and the most difficult and costly holes were those drilled upwards, or those drilled horizontally overhead or on a level with a man's shoulder. The cheapest to drill were downward holes in the floor. It was on this account that our forefathers naturally excavated rock tunnels by driving a top heading first, enlarging afterwards, by taking out the bench with downward holes only.

We now have machines to do our drilling and can drill deeper holes, faster than our predecessors and drill them in any direction. We also have high explosives. Two to four feet for depth of hole, and gun powder, made slow work, to be sure, but the work was smooth, and roof and sides were left as solid as nature made them. To-day we tunnel with



Bottom vs. Top Headings.

10 to 14 ft. holes, and the strongest of dynamite. But we follow the plan of our fathers, in that we drive top headings and smash the roof and sides of our tunnels, by doing so. We are proud because we can beat the record for speed, but pay no heed to the quality of our work.

The American style of driving a heading is perhaps more efficient than the European, and also cheaper. It is known as the center cut system. The holes are drilled in vertical planes, on each side of the center line, some 3 or 4 ft. from that line. The intention is to direct them towards the center line at such an angle that, when finished, those of one side will meet, or cross those of the other side at about the center line (see Figs. 1 and 2.) The ground surrounded by these holes, a wedge shaped mass, whose front edge is formed by the bottoms of the holes, reaches from the floor into the roof and forms the center cut. This center cut, fired first, is too near the roof, generally the upper corner of the front edge is above the line of the roof, and requires an extra heavy charge. From 3 to 5 holes are drilled nearly straight in, outside this wedge, to form the contour of the arch and are fired after the center cut or wedge is out. These holes are called side holes, because they are on the two sides of the cut. The hardness and character of the rock, as regards its resistance to displacement, governs the number and depth of the holes as well as the amount and the quality of the explosive.

When the center cut holes surround a wedge too narrow at the breast and extending too far into the rock, the charge will be very apt to fail bring to it out, and then holes will have to be loaded twice or even three times. In good gneiss it will take at least 50 lbs. of the strongest dynamite to load the center cut, which generally extends half as far into the breast as the heading is wide. The energy of such a charge fired in good rock will, when properly placed and tamped, be exerted in the direction of the shortest and weakest line out, from say, the top of the charge. In the case of the center cut this line is parallel to the axis of the wedge and tunnel, if the rock is massive or solid. If, however, there are any slips or seams above, as at *a*, Fig. 3, on the side, or behind the holes, much of the force of the charge will take that direction until in some cases the *whole* force of the charge will be expended in such direction, and the blast is said to have blown back. When this occurs, the roof over the point of the cut is of course entirely destroyed. If the wedge is only partially removed so that ¼ to ⅓ of its length remains in the point, it obstructs the proper work of the charges in the side holes whose energy has to find vent through the sides of the point of the wedge. Thus if the point remains, the charges of the side-holes will have to injure the sides to a greater or less extent.

The blow of a charge can be likened to the blow of a hammer on a fragment of rock on an anvil. If the blow be heavy enough the stone will be crushed and most of it scattered, but a small, central remnant, will remain on the anvil powdered. In the cut, the charge is the hammer, the back roof and sides the anvil, and the wedge the stone on the anvil. The point of the cut generally answers to the powdered remnant on the anvil. Unfortunately our rock never is as massive and strong as an anvil, but would be more justly represented by a (more or less well burned) brick and the blow of the explosive smashes the stone and the anvil too. Of course, massive rock without seams will stand a large amount of such hammering without much injury; but massive rock without seams would be phenomenal. The great majority of tunnels are driven in stratified rock, and the strata lie or stand in all sorts of positions and are further broken by faults or seams at various angles to the stratification. All such seams tend to lead the force of the explosion away from its legitimate or intended direction, and the result is a very irregular cavern rather than a tunnel.

Twenty years ago the writer drove a tunnel on the Western N. C. R. R. with nitro-glycerine, but had no machine drills. Fearing injury to the roof an intermediate heading was driven some 4 ft. below the roof line, and the latter trimmed down with 6 ft. holes *in the line*, firing small charges without tamping. The result was entirely satisfactory, as it enabled me to follow the roof line closely and leave the roof solid.

Since our predecessors were governed by their stature and their tools, in determining the size of their tunnels, we ought not to follow their method blindly, but rather follow their example and adapt our methods and the size of our tunnels to our wants and the tools we are able to apply. We have machinery and explosives that enable us to dwarf all subterranean work done hitherto, but we should use them so as to do as *neat* work as was done before.

The writer is *sure* that the adoption of a *bottom* heading (if a heading we must have), will result in better and *cheaper* work, without sacrifice of speed, than the usual top heading gives. The center cut in the bottom heading cannot seriously affect the roof, because it is too far below it and there are many more short, weak lines *out* for the explosive than in the top heading. Such rock over the cut, as would be affected by the primary blast, would be still within the tunnel line, would have to come out anyway, and would be so much done towards the removal of the bench or rather stope. The bottom heading, having perpendicular sides, gives more room for handling the drills at the proper angles than the rounded roof of the top heading does, besides being wider and giving more room for the center cut and its charge. The bench of the top heading is covered with tightly packed debris and often water, which have to be disposed of before the downward holes can be drilled in it. The holes have to be charged so as to break the rock loose from the bottom, back and sides, and to *lift* it entirely out of its bed. Afterwards the bottom has to be trimmed to grade, which sometimes is no slight task. The bench or slope of the bottom heading (see Figs. 4 and 5) on the other hand is in full view, clean, and *hanging*. A few horizontal holes, with light charges in them, will bring down the worst of it, and three to five horizontal holes in the roof line, with *very light* charges and *without tamping*, will trim the roof to the line without injuring the rock beyond that line. It seems reasonable to assume that such a slope can be broken down with 60% of the powder it takes to lift out the bench of the top heading.

The writer hopes to see the day when engineers will *insist* on the bottom heading and so get better tunnels without sacrificing speed, and also avoid much of the masonry arch made necessary by the *forced* top heading of to-day.

TO ERASE INK FROM PAPER, ETC.—The *American Druggist* publishes a recent patented composition for the removal and erasure of writing-inks from paper, cloth, and all other substances, without injury to the substance. It is made as follows: Two quarts of water, which has been previously boiled and cooled, add four ounces of citric acid, and after the acid has been dissolved add six or eight ounces of a saturated solution of borax and twelve ounces of chlorinated lime. Place the whole in a stoppered quart bottle, shake well occasionally in the course of several hours, then allow to settle, and decant the clear liquid.

The Carbon Iron Company's Direct Process of Manufacturing Iron and Steel.

We extract the following description of this new and interesting process from a paper on "Some Modern Improvements in Open-Hearth Steel Practice," read by ALFRED E. HUNT, C. E., of Pittsburg, Pa., before the American Institute of Mining Engineers at their late Boston meeting. Mr. HUNT, we may add, has no financial connection with the company, and his paper, we feel assured, is intended as a strictly impartial, scientific account of the process, and it is also the first one which has yet appeared. In our issue of Jan. 21, we gave some account of the remarkable physical qualities of the material, the manufacture of which is thus described:

The Carbon Iron Co., of Pittsburg, has developed a new reducing process for the manufacture of wrought-iron direct from the ore, which, unlike the many processes that have gone before it—all of which with the exception of the Russian Hussavfel process have been failures commercially—seems to be a thorough success. The great trouble with all former processes has been not that it was not easy to reduce the iron and to make wrought-iron from the ore direct, but that the percentage of loss has been so heavy as to condemn the process.

The Carbon Iron Co. uses as a reducing agent, which acts also as a protection from oxidation of the reduced iron, a peculiar graphite which comes from the town of Cranston, near Providence, R. I., it being a mixture between mineral graphite and anthracite coal. It has about the following analysis:

Graphite carbon	78.00 %
Volatile matter	2.60 "
Silica	15.06 "
Phosphorus	0.045 "

The writer well remembers making the first prospective developments of these mines in 1874, and reporting to his clients that it was, for the purpose for which they wished to use it, as an anthracite coal, a perfect failure, that while the percentage of ash was not so excessive but that it could be used near where it was mined without too much expense, the great trouble was that it would not burn freely. This material is mixed with the iron ore, both ground so as to pass through a sieve of sixteen meshes to the inch, and mixed with water so that the mass will mold in the hand easily, and in the proportion of 2,240 lbs. of dry ore to 550 lbs. of the graphite, placed upon a large flat furnace hearth of about 6×23 ft., with the stack in the center of the furnace. The furnace has, for a bottom, simply a layer of 8 ins. of graphite upon the brick work. The charge of steel mixed ore and graphite is spread over the furnace bottom to a depth of about 4 ins., the doors of the furnace well stopped up from ingress of air, and a reducing flame of natural gas allowed to play over the charge from natural gas jets at both ends of the furnace.

In 20 minutes time the charge has sunk to one-half its thickness on the bed of graphite, and the blue flames of carbonic oxide gas are seen coming up all over it, the temperature of the furnace being somewhere in the neighborhood of 1,000° F.

At the expiration of an hour the charge has sunk to one-third of its former thickness, and beads of metallic iron are seen all over the surface. The heat is still kept with the reducing flame upon the furnace for another half hour, when the workmen, with ordinary puddler's hooks, commence the operation of balling up.

The reduced iron rolls up like snowballs in the furnace, and is easily made up in lots of 100 to 150 lbs., when each ball is rolled to one side and other balls are made up. Each furnace will produce, using the Minnesota "Y" ore with 63% metallic iron, from twelve to fifteen of these balls, according to the size in which they are made up, and these weigh from 10 to 12% more than the metallic iron charged in the ore. The heat at no time during the operation has been at all high, the furnace hearth only getting to an orange colored heat, or probably 1,500° F. towards the last of the operation, before the balling up commences; and this orange colored heat is more the reflection of the reduced ore on the melted slag than it is the intense heat of the brickwork and lining of the furnace. At no time is the heat raised to a sufficient degree to melt cast-iron in the production of the sponge for open-hearth stock. The heat, however, is required to be raised to a welding heat if the balls are to be welded.

The chimney is kept well dampered down during the entire work, as a reducing flame is required for the success of the operation. This reducing flame is easily obtained in the furnaces, as used by the Carbon Iron Co., with a 1½ in. natural gas pipe leading to a fire-box at each end of the furnace. The natural gas being under a pressure sometimes as low as 4 oz. The reducing furnaces have several times been run successfully when the natural gas pressure was so low that the puddling furnaces in the adjacent mills have been obliged to shut down. All the balls are made up, in the ordinary practice, before any of them are withdrawn from the furnace. After all the balls are ready, which usually takes about 30 minutes time, they are withdrawn and squeezed in an ordinary rotary squeezer, and rolled into ordinary muck bars or blooms, or taken to a hammer and forged into blooms, or preferably, taken hot to the back of an open hearth furnace. The time taken for the entire operation is about 2½ hours if the balls are to be used in an open hearth furnace, or 3 hours if taken to the rolls. For open hearth work each furnace will deliver eight heats for 24 hours, or sponge balls for a weight of 1550 lbs. of balls per heat.

The principle of the process is that the peculiar graphite used as a reducing agent does not burn out rapidly but remains with the iron in considerable quantities in the sponge, protecting it and allowing the balls to become compact and solid, so that when they are taken from the furnace they do not oxidize very rapidly, but can be squeezed and hammered and rolled without a comparatively severe loss. The oxidation in carrying the sponge balls from the reducing furnaces to the open hearth, although the distance be considerable, is almost nothing. In fact the sponge balls can be taken out of the furnace and allowed to cool off completely in the air with but very trifling oxidation, less than upon an ordinary compact bar of iron of the same weight, and heated to the same degree under the same conditions.

As a stock for the manufacture of open hearth steel the sponge balls produced by the Carbon Iron Co. are peculiarly adapted. It is well known that the best quality of open hearth steel is made by using a pure pig metal, and diluting it with the best quality of new iron blooms. American open hearth managers would almost universally say that the best quality of open hearth steel is made by using a good quality of pig iron diluted with charcoal blooms made in the open Catalan forges of the New York bloomeries. The sponge balls made by the Carbon Iron Co., give the same excellent results produced with charcoal blooms, and have the advantage that they can be charged hot from the reducing furnace into the open hearth bath, in which they melt down as rapidly as put into the furnace, which is not only a great economy in fuel and labor of charging, but also in the rapidity in which the open hearth operation can be conducted, giving a saving of fully 50% in the time of making a heat, and at the same time producing a better quality of steel. It is reckoned that heats of 15 tons of open hearth steel can be made in 4 hours time, with the aid of a cupola to melt the pig metal, and charging the Carbon Iron Co. blooms hot, while it takes 8 or 9 hours at the least with ordinary stock in open hearth furnaces. The open hearth mixture with which these blooms can be economically used, is one third of the total weight of pig iron melted down, first in the open hearth furnace, and in the practice which the Carbon Iron Co. intends to adopt, this pig metal will be first melted in a cupola and run into the open hearth furnaces and then diluted with two-thirds of its weight of Carbon Iron Co. sponge blooms, which are added towards the last of the operation until the bath is low enough to tap. The reducing operation is much better controlled by this progress of dilution with hot sponge balls than by the addition of iron ore in the pig and scrap process. When the gas process is irregular, or for any other reason, the heat is down during the operation, or bad holes are developed or for any other reason it is desirable to get the heat out of the furnaces as quickly as possible, the entire charge being in the melting chamber, there is no other alternative than to go ahead and melt the entire mass down as well as possible, while, by the Carbon Iron Co. process, the heat in the melting chamber, is kept during almost the entire operation under such circumstances that it can be rapidly prepared for tapping. This fact is one that will be greatly appreciated by open hearth managers.

The slag formed during the melting operation, with the addition of carbon sponge blooms, is excessive, and foams up and boils on the top of the bath. At this stage of the operation it is easily removed in large quantities from the charge and allowed to flow out of the doors which have been specially prepared to allow of it. In this way 8 or 10 buggy loads of slag, weighing about 1,500 lbs., can be removed from a 15 ton open hearth heat, this slag does not contain over 10% of metallic iron existing in it as protoxide. Very little metal either is shotted through the slag at this stage. When this slag is properly run off the bath, there is but very little trouble by the slag being in too large quantities on the bath in the after operations when it is necessary for the heat to pass down through the slag to the metal.

The materials used for making the open hearth steel in a 15 ton open hearth furnace are a mixture of two-thirds of the weight Carbon Iron Co. sponge, and one-third of the weight Castle pig iron, or say as follows:

14,000 lbs. Castle pig iron, or 6¼ tons; 28,000 lbs. Carbon sponge balls, or 12½ tons; 420 lbs 72% ferro-manganese; 42,420 lbs. total charge.

From repeated heats made under the personal supervision of the writer, he can safely say that from this mixture we can get 80% of steel ingots, consequently we get 33,300 lbs., with phosphorus below 0.03% or 15 gross tons of steel ingots. Reckoning the scrap at 4% the cost figures out higher than the market rates at present, for making a good enough grade of structural material to answer usual engineering requirements. Bessemer pig metal, rather than the more expensive and superior Castle pig, may be used, giving a steel of below 0.03% phosphorus, and answering fully the requirements for structural purposes, with considerable economy.

The Carbon Iron Co. reckons upon using about 18 reducing furnaces to produce the 28,000 lbs. of sponge necessary to be ready at once for a 15 ton open hearth heat or about 30 reducing furnaces for the two open hearth furnaces that they are now building. Eight heats for 24 hours can now be made in each reducing furnace. The percentage of loss of iron from iron ore to pig iron made ordinarily in the blast furnace runs about 5%. The writer thinks that he is safe in saying that the loss of iron, in the average anthracite or coke hot-blast furnace practice amounts to 7%. Of course this statement refers to the loss of iron from that contained in the ore to that contained in the pig iron, and recognizes that ordinary pig iron has about 1.25% of sand upon its exterior, and that its percentage of carbon and silicon are so high that it does not average over 95% of its weight in metallic iron.

The loss of metallic iron in the puddling process in its product of muck bar, reckoning on not only the iron in the pig added, but also in the iron ore used as "flux" is from 12 to 15%, so that the loss by the ordinary blast furnace and puddling process of manufacture of muck bar is from 17 to 20% of the metallic iron from ore to muck bar. The writer believes the loss of metallic iron from the ore to average fully 20% in wrought-iron, and fully 15% in the puddled blooms that are now largely used in the best open hearth practice. The loss in the average open hearth practice, using pig and scrap, is about 7%; using pig and scrap and puddled or charcoal blooms, at least 10%; or from ore to steel the loss of metallic iron is about 17 to 23%. These figures together with values of, say Pittsburg, or Bessemer pig iron at from $18 to $23 per ton, according as the phosphorus is from 0.07% to 0.04%, of steel scrap of phosphorus below 0.08% at $23 per gross ton, of puddled blooms with phosphorus 0.05% at $38 per gross ton, of ordinary mill iron muck bar with phosphorus 0.15% to 0.20% at $35 per gross ton, of special low phosphorus muck bar of phosphorus 0.03 and under at from $40 to $45 per gross ton, and of Swedish bar of phosphorus 0.01% at $55 per gross ton, should be borne in mind in considering the merits of direct sponge iron for open hearth steel stock. As will be shown later on, the loss of metallic iron averages in the product of over 40 heats in a small experimental open hearth furnace, about 20% from ore to steel ingot and about 10% from ore to Carbon Iron Co. sponge balls, which contain about 83% of metallic iron, on the average. Using 63%

Minnesota "Y" ore, the average percentage by weight of the sponge balls of the iron ore charged is 66.75%, the weight of the sponge balls drawn is about 12% more than that of the metallic iron in the ore added. The loss in the rolling into muck is about 31½%. On account of the low heat at which the sponge balls are squeezed and rolled, a considerable loss is occasioned by masses of the sponge falling off and not being squeezed and rolled into the solid muck bar. This waste, however, is not of iron reconverted into oxide, but is largely metallic iron which has a scrap value of at least $22 per ton to remelt into steel in the open hearth furnace, as it can be readily raked out and separated from the slag and oxide of iron. The percentage of the weight of the Minnesota "Y" ore charged of the Carbon Iron Co. sponge balls is 66.75%; rolled into blooms is about 50%, and into billets about 45%, and into muck bar of 3½ × ⅞ ins. from 42 to 43%. This means that for every hundred pounds of Minnesota "Y" ore of 62% metallic iron charged there is a yield of

Carbon iron sponge balls	66 75 lbs
Carbon Iron Co. blooms 6 × 6 × 20 ins.	50 "
Carbon Iron Co. billets 4 × 4 × 24 ins.	45 "
Carbon Iron Co. muck bar 3½ × ⅞ ins.	42.50 "

The Minnesota "Y" ore is very hard to grind; a much cheaper ore, like the Port Henry ore, can be used successfully, having in the sponge phosphorus about 0.15 % contained in the slag intermingled with the iron in the sponge, making the cost of the sponge, at least, $2.50 per ton less, which with a basic furnace can easily be reduced to phosphorus 0.05 % in the steel, and in dead soft steel to phosphorus 0.01%.

The following is a true copy of a week's run of 3 of the Carbon Iron Co. reducing furnaces, the weights of which were under the writer's personal supervision, and he can vouch for their accuracy. The result this week was unusually good, the average loss being, as before stated, about 31.5 % into muck bar.

Regular charge for each furnace was 2,240 lbs. of Minnesota "Y" ore and 60 lbs. of graphite, which gave the following weights of 3½ × ⅞ in. muck bar.

Furnace number	6 lbs.	7 lbs.	8 lbs.
Monday, Jan. 16	2,965	2,845	2,910
Tuesday, Jan. 17	2,965	2,810	2,990
Wednesday, Jan. 18	2,815	3,005	2,955
Thursday, Jan. 19	3,015	2,955	2,875
Friday, Jan. 20	2,960	2,040	2,980
Saturday, Jan. 21	1,925	1,865	1,935
Total	16,645	15,520	16,645

Total number of heats made by each furnace into muck bar, 17, 16, 17, in all 50 heats.

Each of the above furnaces made 3 heats each day except Saturday, when they made but 2

	lbs.
Total weight of iron ore charged	112,000
Total weight of metallic iron in the ore	69,440
Total weight of muck bar produced	44,810
Loss	20,630 or 29.71%

The Carbon Iron Co. have a small experimental Lash furnace of about a ton capacity, which has been running more or less regularly for the past 4 months with mixtures of Carbon Iron Co. blooms. Below is a record of a heat made in the presence of Mr. ROBERT FORSYTH, Superintendent of the Union Steel Co., Chicago, which is a typical one of many that have been made with the same mixture:

Moorhead pig iron	370 lbs.,	charged at 9.30 A. M.
16 Carbon Iron Co. Sponge balls.	2,010 lbs.,	charged at 10.45 to 11.45 A. M.
70 % Ferro-Manganese.	24 lbs.,	" " 1.10 P. M.
Total charge.	2,904 "	tapped " 1.20 P. M.

The steel was cast into a 14 × 14 ingot and contained

carbon	0.12 %
Phosphorus	0.053 "
Manganese	0.32 "

and had, when rolled and forged into an eye-bar, 6 × 1 in. in section and pulled in a testing machine:—

Tensile strength per square inch	63 630 lbs
Elastic limit " " "	42.500 "
Elongation in 10 ft.	17.58 %
Reduction of area	35.1 "

The sponge balls were made from reducing furnaces No. 7 and 10. The entire product of furnace No. 10 in 12 sponge balls of the following weight were put into the open hearth furnaces as follows:—90, 155, 85, 150, 130, 185, 130, 135, 110, 95, 155, 120; total 1.540 lbs.

From furnace No. 7 was charged 4 sponge balls of the following weights; 115, 110, 125, and 120, or together 470 lbs. additional, making a total of 2,010 lbs. in the open hearth furnace.

The charge in each of the reducing furnaces was the regular one with 2,240 lbs. of Minnesota "Y" ore of 62% metallic iron and 550 lbs. of graphite. The metallic iron contained in the ore was 1,390 lbs. The loss in the reducing furnace as proven by the weight of steel produced from the sponge is about 10% which taken from the 1,390 lbs. of iron would leave 1,290 lbs. of iron in the sponge, or the sponge contained about 881-23% of metallic iron estimated in this way.

It is very difficult to get the percentage of iron in the sponge by analysis, as it is not at all homogeneous as to the amount of contained slag and graphite.

The steel ingot weighed 2,150 lbs., the scrap weighed 191 lbs., yielding a waste of 563 lbs. or in percentages of the total charge of 2,904 lbs.:—Ingots 74.00%, scrap 6.58% to 19.42% loss. The small open hearth furnace has proved by charges of regular pig and scrap mixtures to give a loss of about 11%.

The same mixture, used in the Lash open hearth furnaces has yielded about 7% loss, giving an excess of about 4% less for this small experimental open hearth furnace over that which would be obtained ordinarily with a large open hearth. This excess of 4% can fairly be substracted from the percentage of loss given above 19.42% yielded by the small furnace, giving a total loss of between 15 and 16% which can be safely predicted to be the loss by the process in actual open hearth practice in 15 ton furnaces.

Of this loss from 6 to 7% is the loss in ordinary open hearth practice, and from 9 to 10% in the reducing furnace. This loss of iron, of say 16% it must be borne in mind is the total from ore and pig metal to steel ingots, and is simply loss of iron from the ore and not a loss of iron from the manufactured product.

The cost per "unit" or per cent. of iron in this loss is about, say $9.30 per ton for the ground ore, or say $15 per ton for the iron; while the cost per unit for the loss by the pig and scrap process is at the direct values of the stock used, at least $20 per ton.

The Minnesota "Y" ore used in the above experimental charges contains:

Iron	62.16 %
Silica	5.54 "
Phosphorus	0.063 "

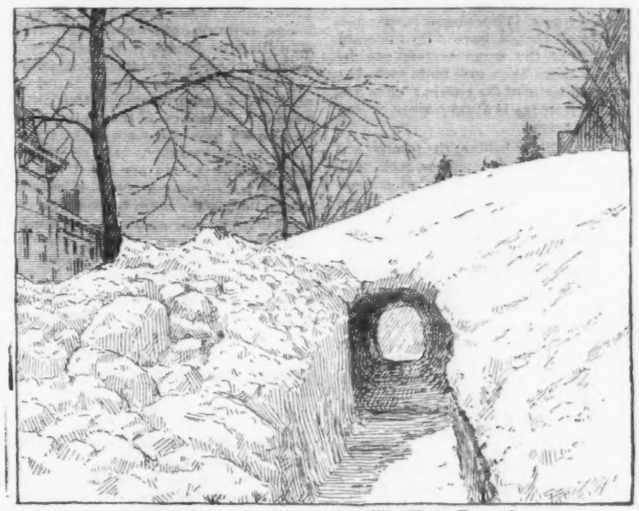
There is ordinarily very little slag taken from the reducing furnaces after the sponge balls are withdrawn, for the open hearth furnaces, about 18% of foreign matter in the sponge balls carrying out about all of the gangue of the ore together with some graphite. On this account the operation is not much of a reducer of phosphorus until the slag is removed from the open hearth bath which carries off a large amount of it. However, if the reducing furnaces be heated hotter, as is necessary when the balls are to be rolled, then a considerable slag is formed, weighing from 300 to 400 lbs. per furnace. This slag carries nearly the whole of the phosphorus, as very little, in fact almost none, is left with the iron reduced at the low temperature of say 1,500° F. employed in the reducing furnace.

The muck bar from the Minnesota "Y" ore Carbon blooms contains less than 0.015% phosphorus. Using the Minnesota "Y" ore, this slag from the blooms when they are heated hot enough to roll, contains: Iron, from 30% to 50% as protoxide; Silica, from 24% to 30%; Phosphorus, from 0.10% to 0.15%.

In the experimental heat mentioned above, the ore mixture was charged into the reducing furnace at 9.10 A. M., and the pig was charged cold at 9.30 A. M. Into the small open-hearth furnace the charge of steel was cast at 1.20 P. M., making 4 hours and 10 minutes from ore to steel ingot. The steel made by the Carbon Iron Co., from their sponge blooms in an open-hearth furnace, certainly has given the best results yet obtained for structural purposes. It has already attracted favorable comment from many engineers. ENGINEERING NEWS has in a late number (Jan. 21,) devoted over a page to the recitation of some of the results obtained from it in the shape of angles, plates, and eyebars. The rapidity with which the steel can be made, its economy of materials, and excellent behavior under test and in use, makes the writer confident that it has a large future before it.

The New Tarrytown Tunnel.

The new engineering work which we illustrate



Engineering in Tarrytown—The New Tunnel.

while not a work of any great magnitude, being only 79 ft. long, 6 ft. high and 6 ft. wide, will long be memorable even in this age of fast tunnel-driving for the remarkable rapidity with which it was driven. The headings closed on March 20, 1888, and it was put through, according to the official report of the engineer in charge, in less than four hours, being at the rate of 474 ft. a day, a performance which is justly regarded as very remarkable. The material was somewhat more favorable than usual, it is true, being snow, but as that little detail is frequently passed over in reports of fast tunnel driving, especially in comparative records of work done by power drills, we do not see why it should be dwelt upon in this instance. The method of aligning the tunnel was also strikingly novel and simple, being merely to follow the curb stone; a suggestion, we presume, of "the lady from Philadelphia," since so common and unprofessional a way of aligning a tunnel would hardly occur to an engineer, any more than it did to JOHN PHOENIX to determine time in any other way than by astronomical observations.

The engineer in charge of this interesting work was Mr. J. IMBRIE MILLER, who is also principal Assistant Engineer of the Northern District of the new Croton Aqueduct, at least, we presume he was, as we are indebted to his kindness for the view which we present, which the engineer in charge, had there been any other, would hardly have neglected to send to us. In a similar manner we have ascertained that Mr. WM. D. KELLY, Jr., by whom the view was taken, was Principal Assistant Engineer. The snow drift was considerably higher than it looks, having been about 16 ft., and was located on the sidewalk of Beekman Avenue, North Tarrytown, N. Y. The tunnel has attracted unusual attention for an engineering work, and has been illuminated at night by Chinese lanterns and continually filled with visitors.

A TRESTLE near Beech Ridge, Ill., on the Mobile & Ohio Railroad, was wrecked by 3 derailed freight cars March 14.

A Discussion of Long Span Bridges.

BY GUSTAV LINDENTHAL, M. AM. SOC. C. E.

(*Concluded from page 175.*)

6. RELATION OF END SPANS TO MIDDLE SPAN.

The middle span will rise and fall nearly 4 ft. from the normal position at a mean temperature of 50° F. so that the clear height above high water, will be in midsummer nearly 8 ft. less than during the month of January of the coldest winter. In a bridge with a series of suspension arches a transient load on one span will effect all the others. If this transient load is a heavy train, or a number of heavy trains meeting on the same span, then the deforming effects on the other main or full spans can become too great for safety; always assuming that the towers will not resist any part of the tension on the cable, as they should not, unless specially built for it. Such towers between main spans built to resist the differences of tension in the cables from loaded and unloaded large spans would be very costly, and would nullify the economy, which otherwise the use of the inverted arch so preeminently offers over all other systems. Therefore a suspended arch bridge for a railroad should have only one main span. A wagon bridge of the same system can be conveniently built for more than one main span, because the deforming defects of the passing loads are not so great, and such a bridge is always more or less uniformly covered with teams.

In the proposed North River bridge, the towers are not intended to resist such differences of cable tension beyond what is caused by the frictional resistance of the ball-bearings under the cable-supports. There will be only one main span and two end spans, as shown. In the case of a three hinged middle span, the loaded end spans would have to resist unaided the action of the live loads producing positive bending moments. Likewise if the middle span alone is loaded, both end spans must resist negative bending moments, unaided by the middle span. As a result the bending moments, negative or positive, in the end spans, if they are in length each equal to half the middle span, would be nearly twice as great as in the coresponding halfs of three hinged middle spans.

In arches hinged at the ends only, a different condition of load effects obtains; namely, a train on the end span would affect the middle span and other end span to the extent of making (H), the horizontal component of the live load cable tension in the end span if loaded alone the same throughout the suspended arches, (disregarding the roller friction on the towers), thereby producing negative bending moments in the unloaded middle span, and the other unloaded end span.

On account of the end spans the bending moments positive and negative in the middle span, with end hinges only, are greater in the inverted arch than in an erect arch. Greater bending moments means greater deflections, and although arch bridges deflect less than other bridge systems and eight times less than truss bridges of the same height, it is best even here to keep the deflections down to the lowest attainable minimum. For this reason, and to avoid (on account of the roller friction in the towers) larger bending moments in the end spans than in the middle span, the novel device of middle-supports or anchor trestles under each end span has been introduced.

These anchor trestles or anchor posts bear no part of the uniformly distributed dead load, and come into use only from the action of the live loads. A solid masonry pier would be unsightly and is unnecessary. The iron anchor trestle is constructively correct and therefore does not mar the appearance of the bridge. A masonry pier would be constructively incorrect and would be offensive to the eye. If the live loads were of the same character as in the East River bridge, no such special provision would be necessary. But for the heavy concentrated loads of trains and locomotives it is best to make it.

An equivalent arrangement in the end spans for the anchor trestle would take the form of stiffening trusses of equal depth with the arch ribs proportioned to take up, together with the arches, the positive and negative bending moments, so that the excess beyond what the ribbed arches could safely resist, without causing compression in the cables, would be resisted by the stiffening trusses. But this arrangement, as calculation shows, would require such heavy sections in the girders, as to greatly increase, and to disturb the otherwise very nearly uniform rate of dead load of the superstructure. Besides it would be many times more costly than the arrangement with the anchor trestle.

This trestle is under compression when the train passes over the end span, and in tension when it is on the middle span. It can be so accurately adjusted, that the assumptions for calculation are strictly complied with and no uncertainty can exist as to the resulting stresses in the arches. These latter are obtained for the end spans by superposition of the stresses in a curved girder continuous over three supports with those resulting from the uniform dead load in the arches, for which the anchor trestle is not needed.

The pressure on the anchor trestle can be kept within previously determined limits, by setting the trestle-posts on levers balanced by weights of stone or pig iron and hidden in the masonry pedestals. With such a device the tension in the lower cable above the trestle support could never be reduced beyond a certain predetermined stress-value.

I may remark that two trains meeting on the end span will hardly affect the anchor trestle, the beneficial use of which of course is greatest when the entire end span would be loaded with locomotives on all six tracks, and no loads on the other spans.

The end spans of the North River bridge, like those of the East River bridge, will reach over valuable property on both sides of the river, which for any other arrangement would be greatly depreciated in value if not destroyed for business purposes. The longer the end spans are on this account the better up to a certain limit. For convenience and economy of construction and for greater stability the cables should enter the anchorages below the floor grade, thus reducing the leverage for overturning them. The arches of the end spans, as a rule deflect more than in the middle span. The limiting length of the end spans in suspension bridges, when uniform load alone is considered, should be that for which the tangent to the cable curve at the anchorages is horizontal so that there is no vertical pressure of reaction at that point. If the cables in the end spans have the same curvature as in the middle span, the limit would be half the length of middle span. For a uniform load per lineal foot, the equilibrium curves are of course common parabolic in all three spans, having the same horizontal component of cable tension. The end spans having the larger deflection must therefore be made longer than the middle span in the proportion of the squares of lengths of full spans to their respective deflections.

So that if $2s$ is the length of middle span
s_1 is the length of end span
h is the deflection of middle span
h_1 is the deflection of end span

Length of end span will be

$$s_1 = \sqrt{\frac{s^2 \, h_1}{h}}$$

a proportion of lengths of spans, approximately carried out in the East River bridge.

Local conditions may sometimes fix the site of the anchorages irrespective of any rule; then the curvature and design of the end spans must be modified accordingly. Another modifying condition for length of end spans may arise from the proportion of live load stresses to dead load stresses in the end cable arches. As already observed, the bending moments from live load can happen to be greater in the end spans than in the middle spans. Where the proportions of live load to dead load is less favorable, and where an anchor trestle cannot be used, the length of the end span should be so reduced that the chords strains in the arches or cables of end spans shall not exceed those of the middle span for cables of uniform section. In a suspension bridge with a link cable, in which the section of the links can be varied to the strains, and n be also stiffened to resist compression. the length of end spans will not depend so much on the above considerations.

It is well known that when the deflection of the arch does not exceed one-tenth of the span the curve of the cables can be assumed as circular without material error. The calculations of the dimensions of the ribbed arch are simpler, and greater simplicity also of construction is insured.

CONCLUDING REMARKS.

The proposed North River bridge, large as are its proportions, will require no unusual facilities or special tools or machinery for its construction. As far as the anchorage, piers and foundations are concerned they present no new problems. The work is merely on a larger scale requiring more plant and larger number of men and tools. The iron towers likewise offer no difficulties. With the existing shapes from rolling mills, with the facilities now in use for the erection of large bridges, they can be finished piecemeal at the shop ready for erection.

The construction of wire cables is no new thing, and the great precision required will depend on highly trained engineers constantly present with skilled mechanics. The manufacture of 12-in. eyebars some 70 ft. long for the arch web members may be said to be the only innovation proposed. But it is to be remembered that such eyebars are already now wanted for large truss bridges and would be used if they could be had. The manufacture of the iron work for the platforms is of course of an every-day character. The erection of the bridge without false-works is too evident a feature to be more than mentioned.

It remains yet to be said that the cost of the bridge is approximately $15,000,000. There are many points and questions of which the author would have liked, and expects on another occasion to say more in detail; the subject is too extended already to present at this time more than the leading features of construction.

Boston Water-Works.

Fisher Hill reservoir, views of which are given this week is the latest addition to the Boston water-works system, and was completed Nov. 18, 1887, and filled to high water mark Jan. 6, 1888. The description, as well as the summary of statistics relating to the water-works are obtained from the twenty-first annual report of the City Engineer, for the year 1887.

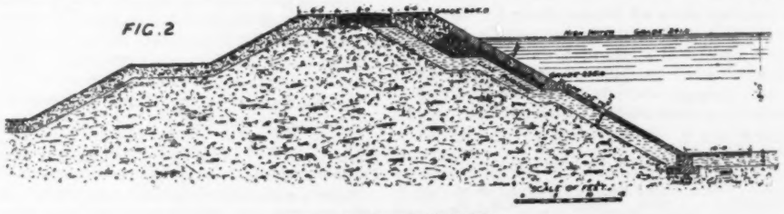
The reservoir is of rectangular shape, built partly in excavation and partly in embankment, 500 ft. by 295 ft., measured at top of inner slope of embankment, and 423 by 218 ft. at the bottom of slope. It is situated on one of the highest hills about Boston, about four miles west of the center of the city, in the neighborhood of the Chestnut Hill reservoir, and is the largest storage basin of the system, the high water mark being 241 ft. above tide marsh level.

The embankment is 20 ft. wide on top, with outside slopes of 2 horizontal to 1 vertical, and inside slopes of 1¾ horizontal to 1 vertical, and is composed of the material from the excavation, a compact clayey earth, spread in 4-in. layers, watered and thoroughly rolled. The inner slope of embankment is covered to above high water line with a layer of puddle 2 ft. thick, composed of ⅔ natural material and ⅓ brick clay, wet and rammed in place. To within 10 ft. of high-water line the puddle is covered from base of slope with a 9-in. layer of Portland cement; from this point to 2 ft. above high water line, the slope is paved with Roxbury stone, 15 ins. thick, underlaid by 12 ins. of small broken stone.

At the foot of the slope an abutment of American cement concrete is placed, as shown on section, Fig. 2, to prevent any slipping of the puddle or paving on the slope. The bottom of the reservoir is covered with 2 ft. of natural material with a small quantity of clay, wet and rolled. For 10 ft. from the foot of the slope the bottom is covered with a 6-in. layer of Portland cement concrete.

Drainage is effected from the center, to which the bottom slopes, by a concrete gutter leading to the gate-chamber.

FIG. 2.

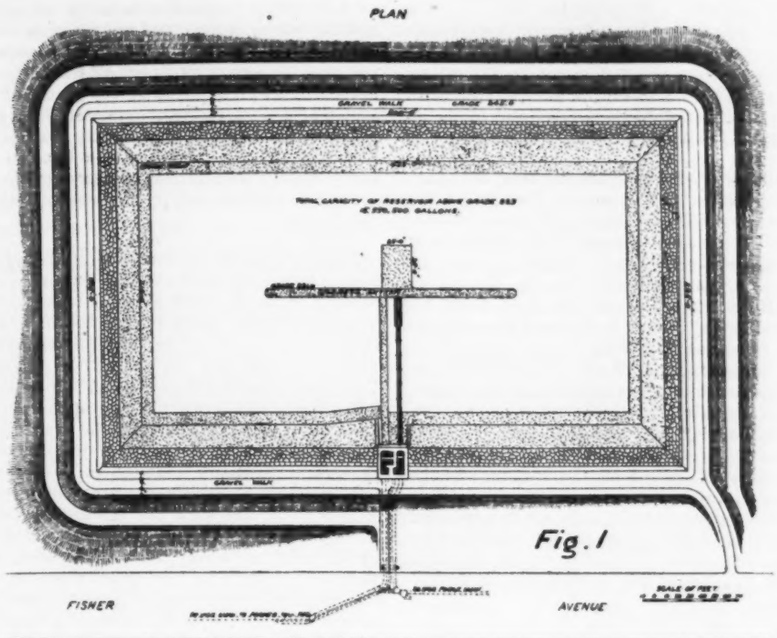


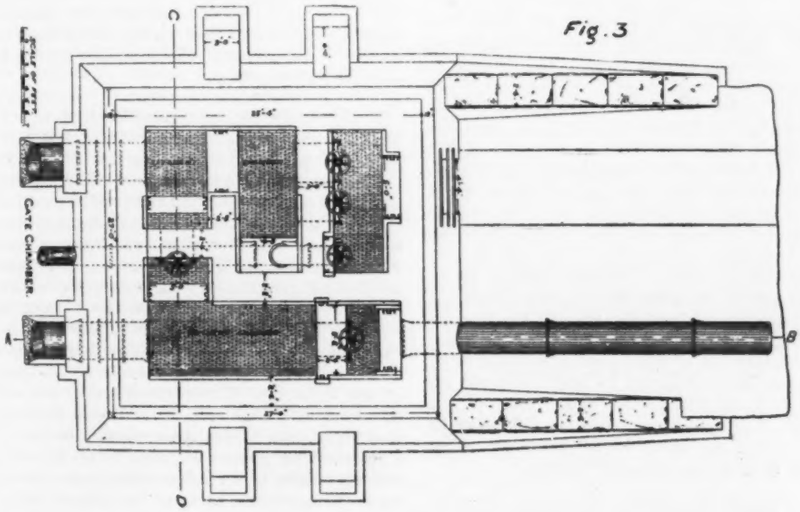
SECTION OF EMBANKMENT.

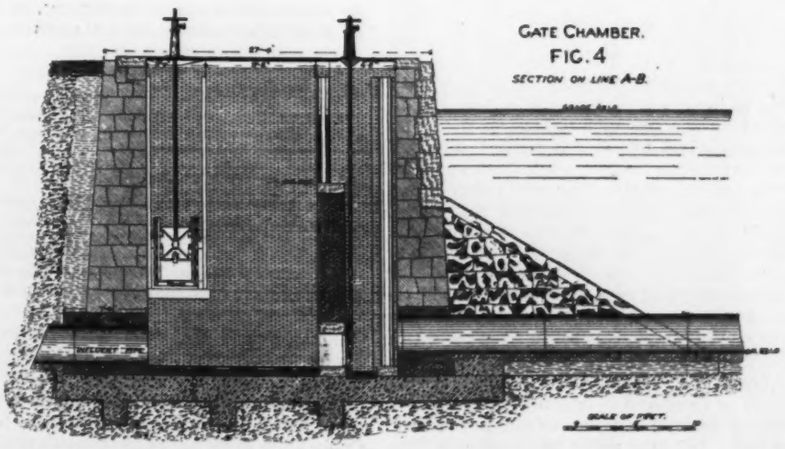
Fisher Hill Reservoir: Boston Water-Works.

The outer slope of the embankment is covered with 2 ft. of loam, and a gravel walk, 8 ft. wide, surrounds the reservoir on top of the embankment. The gate-house superstructure is brick, with trimmings of Longmeadow brown-stone. The gate-chamber, 20 ft. × 20 ft. 10 ins. inside dimensions, is located in the center of the easterly embankment, and has side walls of rubble granite masonry, 26 ft high, 5 ft. 6 ins. thick at bottom and 3 ft. 6 ins. at top. It is divided by brick partition walls into influent and effluent chambers, as shown in Figs. 3 to 5. The foundation course is a bed of American cement concrete, 2 ft. thick, below which there are three cut-off walls of concrete, 2 ft. square, running parallel with the center line of embankment to cut off leakage.

The water enters the gate-chamber through a 36-in. pipe, passes out through a 36 in. pipe and enters the







Fisher Hill Reservoir; Boston Water-Works.

reservoir near the center. A brick division wall, with sluice-gate at the bottom and stop-planks above, prevents the reservoir from being emptied in case of a break in the force-main. Water can be taken from different depths by means of two sluice-gates in the effluent chamber. The overflow and drainage pipe is 16-in. diameter, reduced to 12 ins. outside of the reservoir, and is connected with a surface drain on Boylston St.

The cost of this reservoir was as follows: land, $29,042; construction, $75,967; sluice-gates, etc., $1,215; gate-house substructure, $8,912; miscellaneous, including engineering, $9,948; total, $188,084.

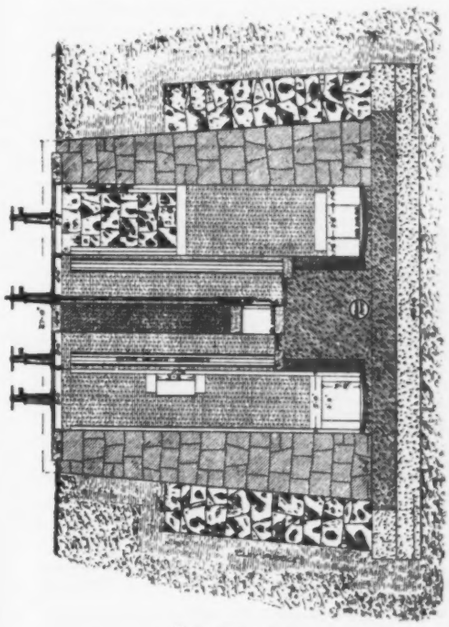
The daily average consumption of water from the combined Cochituate and Mystic works, during 1887, was 37,481,100 galls.

The daily average consumption per head of population, was 79 galls., which shows an increase over that of the year 1886, of 10.1 per cent.

The Main Drainage Works show the average daily amount of sewage pumped in gallons as follows:

1885	1886	1887
33,874,575	36,866,129	43,630,657

Maximum daily amount pumped in 1887, 116,972,-



GATE CHAMBER.
FIG. 5
SECTION ON LINE C-D.
SCALE OF FEET.

611; minimum, 27,796,176 galls. The cost of pumping was $32,166, or $0.0585 per million galls. lifted 1 ft. high.

At the main drainage pumping station there was pumped by the four engines in 1887, a total of 15,-905,146,275 galls.; daily average, 43,630,657 galls. Daily average amount of coal used, 12,677 lbs.; per cent. of ashes and cinders, 11 7; gallons pumped per pound of coal, 3,444; duty in foot pounds per 100 lbs coal, 99,560,914.

THE Indianapolis *Journal* is responsible for the statement that a Mr. JOHN JONES, "engaged for 3 years past by a railway company in China," is in Albany, N. Y., with a commission to engage 500 engineers, firemen and brakesmen to run trains in China on the American system. The pay offered, $250, $175, and $125 monthly for engineers, firemen and brakesmen respectively, should bring a host of applicants; but as we understand the mileage of Chinese railways, there is hardly enough track to divide among even a fifth of the number of employés stated and we doubt the demand—just now.

IT is stated that the hollow iron pier, 30 ft. high supporting the great telescope at the LICK Observatory must be replaced by one of solid masonry. The iron pier has proved so susceptible externally to change of temperature that it is said that the mere placing of the hand on it is sufficient to throw a star out of the field of the telescope.

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D. McN. STAUFFER. A. M. WELLINGTON.
EDITORS.

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Drawings for publication *should preferably be in plain black and white, considerably larger than they are expected to appear, with letters and figures in pencil only, all lines clean and bold.*

Coming Technical Meetings.

Civil Engineers' Club of Cleveland, O.—Regular meeting, March 27; Scientific Pursuits. Secy., C.O. Arey, 31 Blackstone Building.

Engineers' Club of Kansas City, Mo.—Regular meeting, April 2. Secy., Kenneth Allen, 19 Deardorff Building

Civil Engineers Society of St. Paul, Minn.—Regular monthly meeting, April 2. Secy., GEO. L WILSON, City Hall.

Western Society of Engineers, Chicago, Ill.—Regular meeting, April 3. Secy, L. E. Cooley, 171 La Salle St.

Engineers' Club of St. Louis, Mo.—Regular meeting, April 4. "Thickness of Water Pipes," S. B. Russell. Secy., W. H. Bryan, 709 Market St.

American Society of Civil Engineers, New York.—Regular meeting, April 4. Secy., John Bogart, 127 E. 23d St.

Engineers' Club of Philadelphia, Pa.—Regular meeting, April 7. Secy., Howard Murphy. 1123 Girard St.

Association of North American Railroad Superintendents.—Next meeting in New York, April 9.

American Water-Works Association.—Annual meeting at Cleveland, O., April 17, 18, 19. Secy. J. H. Decker, Hannibal, Mo.

Boston Society of Civil Engineers, Boston, Mass.—Regular meeting, April 18. Secy., S. E. Tinkham, City Hall.

American Society of Mechanical Engineers.—Meeting at Nashville, Tenn., in April or May. Secy., F. R. Hutton, 280 Broadway, New York City.

Master Car Builders' Association.—Next convention at Alexandria Bay, N. Y.; commencing June 12. Secy., M. N. Forney, 45 Broadway, New York City.

American Railway Master Mechanics' Association.—Next meeting at the Thousand Islands, N. Y.; June 19. Secy., Angus Sinclair, Chicago.

Roadmasters' Association of America.—Next meeting at Washington, D. C. Sept. 11. Secy., H. W. Reed Waycross, Ga.

THE death of SQUIRE WHIPPLE, on March 15, removes from the engineering world a man who by his individuality and originality practically created the modern art of bridge construction; not only in substituting iron for wood in bridges but in also pointing out the law governing the distribution of strains in framed structures and the proper proportioning of the various members in such structures. To the best of our knowledge he was also the first to introduce the pin-connected bridge, now know throughout the world as the great distinguishing feature of American construction. In any event the bridge referred to in the memoir elsewhere printed contained in 1852 a pin in the top chord, used almost exactly as in the present practice. If any earlier use of the pin can be shown we should like to hear of it.

Mr. WHIPPLE seemed to labor purely for results and in the interest of progress in bridge construction; he was modest in his claims and pushed them so little that he realized very slight financial profit from any of his inventions. But it should not be forgotten in the stirring, selfish present that he first pointed out the road that has in the last forty years led to such triumphs in metal bridge construction. It took some years to combat public prejudice and doubt; but that one of his earliest bridges successfully stood hard service for 30 years, and was then only removed because of the enormous increase in the rolling loads, is a sufficient and convincing proof of the soundness of his reasoning and of his remarkable knowledge of construction.

IN spite of the unfortunate time at which the report of the Board of Experts of the Brooklyn Bridge was made public, in the very midst of the great blizzard, the great strike, and the great Emperor's death, it has attracted great attention from the New York and Brooklyn press, all of which have described and discussed the matter more or less fully, as was natural from the local importance of the question, and all of which have spoken with pleasure and approbation of the plans, with one partial and curious exception.

The Brooklyn *Standard-Union*, while thinking the plans otherwise "of broad and promising scope" is moved by the stoppage of the bridge cable cars during the late blizzard to remark that the cable is only a "fair weather system," and its capacity much less than by locomotive power (!) the possibility of using which, it alleges, was not considered by the experts.

The fact that the Hoboken inclined cable railway, a mile or more in length, was operated throughout the storm without interruption, and was the only means of transit anywhere in the vicinity of New York which did so, (with the sole exception of the Suburban Rapid Transit Railway, elsewhere noted) is a sufficient answer to the "fair weather" charge. It shows that if cable traction failed on the bridge there must have been special reasons for it. On the contrary, the peculiar advantage of a cable system, when the cable does not have to be buried under the street, is that it can continue in operation when others cannot, because the condition of rail or weather is unimportant to it, so long as the cars are able to keep the track. As it also eliminates the effect of grades, both to waste power and to cut down the length of trains, it is peculiarly adapted for use on the bridge, and its further advantage that it insures absolute uniformity of speed and equidistance of trains is likely to insure its continued use on the bridge for many years if not forever; although of course it can make no difference in the general arrangement of terminals what motor is used, provided it "motes."

IN a lecture before the American Institute Mr. GEO. L. FOWLER, objected to the new street rail proposed by Mayor HEWITT. He says it is the same as adopted for the standard rail on the lines of the *Compagnie Generale des Omnibus*, of Paris. The foundation trench is 8 ft. wide and 14 ins. deep and has in the bottom 8 ins. of broken stone mixed with cement and floated on the top with concrete. The rails rest on this bed, two double-headed rails with a space between forming each track and resting in cast-iron chairs. The rails weigh 40 lbs. per yard and the whole road-bed costs about $14,000 per mile. Mr. FOWLER said that this cost was excessive as compared with the $10,000 per mile of the most approved American construction, and that the rails would be forced apart by the mud freezing between them, and other troubles result from the filthy condition and generally bad drainage of our roadways. All of which is true; but our streets should be improved in just this direction and it would not be a bad idea to commence with our street railways under arrangements that would not be too severe upon the struggling companies owning them.

THE late storm is being very properly used as a powerful argument in favor of underground wires, in the cities as well as between great cities. The fact that the metropolis of this country was entirely cut off from all communication with the rest of the country for a period of some days, is phenomenal; but it may happen again and it is a possibility that should be removed. The only question is as to the most efficient and available system of underground protection, and the first cost of making the change.

THESE are the points that are now being discussed before the authorities of Boston in connection with a petition of certain parties praying for the exclusive privilege of constructing and maintaining conduits on certain streets in that city for a period of 20 years. Very considerable testimony has been brought forward and the fact made very apparent that there is strong opposition to the granting of exclusive privileges. The Western Union Telegraph Company, through its representative, says that it introduced the conduit system in Boston in 1884 with the intention of completing the work of burying all its wires. It has 35 miles of wires now underground, and decidedly objects to laying its wires in the conduit of a foreign company, and thinks compulsion in this respect would be a great injustice. The Edison Electric Illuminating Co. made a similar objection on the ground of mechanical difficulties requiring a special conduit. The experts very generally testified that the telegraph and telephone wires should not be in the same conduit with the electric lighting wires, and that an exclusive right on certain routes to any one company would be against public policy.

THE remedy for this complication of disorders would seem to be a little of the same medicine proposed by Mayor HEWITT for the rapid transit tangle in this city. Let the city build and own and control the conduits subject to a rental by any incorporated company, and make their use compulsory. Such a plan would remove all question of exclusive privilege and give the city full control of all excavation and construction on the line of its streets. But in such a disposal of the question the experience of the city of New York should be a warning, as pointing out one of the ways of not doing it. Experienced engineers and expert electricians, and not political favorites and legislative committees, should be put in control. The proper disposal of all kinds of electric wires is an engineering problem of huge proportions, and, as we have before pointed out, it is better to delay the work than to use mere temporary make-shifts that entail an expense and public inconvenience out of all proportion to their life and usefulness.

A CORRESPONDENT writes us:

In your issue of Feb. 18, you quote from Professor DIETRICH of Berlin, on brick and stone bridges of large span, that there are in existence three bridges "of from 200 to 230 ft., and only one, the Cabin John arch, near Washington, exceeds this limit and has a span of 237 ft."

There is one error here. The span of Cabin John arch is 220 ft. Will you kindly give the names of the other three "from 200 to 230 ft." span? Not many years ago the next largest to Cabin John was the bridge over the river Dee at Chester, 200 ft. span. That over the Adda in northern Italy, had a clear span of 250 ft., but it does not now exist."

Our correspondent will have to apply to Professor DIETRICH. We simply told the tale as 'twas told to us, which was through the columns of *Engineering*, and remember being surprised at the time at the span given for the Cabin John arch, but unfortunately neglected to check it by investigation. Our understanding of the matter was, and is, precisely what

our correspondent says, but there may well be in some part of the world, old stone arches of large span which German industry has hunted out, and which are not generally known. Failing further evidence we shall continue to believe that the Cabin John arch, 220 ft., and the Chester arch, 200 ft. are the greatest in the world.

Bridge Floors and Car Stoves.

Last winter was signalized by a very remarkable series of railway accidents culminating in the White River disaster, in which fire played a terrible part. Even the Bussey bridge disaster, although the crowning horror of fire was barely escaped, came so very near to it that it greatly helped toward the very remarkably active movement for the introduction of steam heating which has gone so far that there is hardly a great line in the country which has not one or more steam heated trains in service, and probably not one which has not done more or less experimenting or other preparatory work.

This winter has been as remarkably free from such accidents as last winter was crowded with them, while on the other hand the late unprecedented Eastern blizzard, and several others which happened in the West, have done much to emphasize an undoubted danger from steam heating by the locomotive only, that the locomotive will be detached or become dead in snow storms, and that train-loads of passengers will be left helpless between stations without any means of heating. Our prediction which seemed a perfectly safe one last winter, that somewhere this winter the burning of some carload of passengers would make it exceedingly unpleasant for officers who could not show that they had used due diligence in substituting steam heat for car stoves, has so far not been fulfilled, and there is such a brief period of cold weather yet to be lived through that it seems unlikely that it will be fulfilled. On the contrary, in a number of this winter's accidents, as notably in the great trestle accident of this week in the South, which is the only very serious one of the winter, the danger of fire has been so easily escaped (to all appearance) as to deaden the public sense of danger from that source, and as railway officers are only men, it has beyond doubt has much the same effect on many of them. The danger of not having separate heaters in cars in case of blizzards, is for the moment the freshest in the minds of both railway officers and the general public.

Under these circumstances the advocates of old methods of heating have taken fresh heart. A manufacturer of car heaters, masquerading under the title of "Old Railroader" (which he is not) is sending a series of long letters to the daily press pointing out in the interests of humanity how entirely absurd and unsafe it is not to have separate heaters on each car, of a pattern resembling those which he makes; and he succeeds in calling out approving comments from the very journals whose columns were lurid last winter with unpleasant comments on those who should longer neglect to heat by steam.

That great engineer, orator, railway manager and presidential candidate, Mr. CHAUNCEY M. DEPEW, has likewise returned to his first love. It will be remembered that in the early part of last winter, until after the White River disaster, he made repeated and emphatic assertions that it was chimerical and absurd to think of heating from the locomotive; it could not spare the steam; boiler plate stoves were safer, etc., etc. But the pressure of events was too strong. Soon after the Bussey Bridge disaster, he experienced a change of heart, and came out as emphatically in favor of steam heating, and his company has since been one of the most active in the country in introducing it. It has a number of steam heated trains actually in service, and unless there has been a very recent change of policy, is actively pushing the equipment of all its passenger stock.

But the current of late events has been too strong for him. He had several trains stuck in snow drift salong the Harlem river, and, unless he has been greatly belied in several reported interviews, remarked in consequence, that: "One thing is settled by this experience. Nothing can take the place of a heater on each car. We must have it for storms." Less conspicuous railway officers have been slower to come forward in this manner, but several interviews to much the same purport have been published, and unless we are greatly mistaken there has been a marked decrease in the activity with which steam heating was being pushed. It is probable that many roads will take advantage of this winter's immunity and of the late great storm to lay back on their oars somewhat, pleading that they can not exactly determine what to do.

It behooves the technical press to sit down emphatically on any such misuse of a single phenomenal incident and a single winter's immunity, and to point out especially that in the latest and only serious disaster of the winter all the conditions were present for the most horrible holocaust on record, except for one man's presence of mind and other favoring conditions. Fire broke out, but it chanced to be extinguished a moment after. Had the attempt been made five minutes after, it might well have been too late, for circumstances cannot be imagined more favorable to the quick spread of a fire than the fall of a train of cars one upon the other from the top of a pitch pine trestle 30 ft. high. Once well started it would have burned with the greatest fury. Must a score or so of lives be lost from such dangers to have the warning appreciated?

The difficulty of sufficiently heating snow-bound trains is really in no respect a serious one. In the first place, if the locomotive be not detached it is nearly always possible to keep its fires alive enough to heat a train under the most adverse circumstances, and the detaching of locomotives to try to butt through snow-banks is so dangerous and nearly always ineffectual that it would do no real harm to positively prohibit it in case of severe storms. Nine times out of ten, if not ninety-nine times out of a hundred, the only useful effect is to get the train a mile or two further ahead before it finally stalls. The number of cases in which the train is taken through to the terminus, or a large station which it otherwise would not reach, is very small, while the great danger to the trainmen of using locomotives as a battering ram against snow drifts has been illustrated by at least two dozen locomotive smash-ups in the late storm, many of them accompanied by loss of life or limb.

In the second place, by carrying regularly in the winter time a small heater and supply of coal in the baggage car, steam enough to heat three or four cars sufficiently well for an emergency can always be assured at small cost of money or space. In the third place, several of the steam-heating systems now in use, including one of much promise, still leave a heater on each car, in which a fire can be started if necessary to heat through the same pipes, although this seems unnecessarily wasteful of space except in the regions where severe storms are frequent in every winter. Finally, two or three cars of a train may have car stoves of ordinary pattern in them for use in such emergencies only, which will suffice to prevent any actual suffering by abandoning the other cars of the train.

In one or the other of these ways the minor danger of freezing can be sufficiently guarded against, without retaining the vastly more horrible danger of burning up passengers alive, which has been imminent in a dozen disasters this winter, although it has been escaped in all.

The Savannah, Florida & Western disaster shows this clearly, but it shows still more clearly the folly and wickedness of constructing trestles and bridges with such floors as are too common, and without the re-railing devices which we have so often insisted, and shall continue to insist, should be used at each end of every such structure. In this last disaster, it is at least extremely probable that good bridge floors and good re-railing guards would have saved the whole disaster.

We have not been able to secure as yet any precise information as to the exact details of the floor. The press dispatches, as usual, miss many of the most essential details completely, but the general course of events is sufficiently well described to make the moral unmistakable. With as much certainty, perhaps, as in any disaster which has ever occurred, we may say that either re-railing guards or good trestle floors, and still more both would have either averted or greatly mitigated the disaster.

The front truck of the baggage car became derailed "fully a quarter of a mile" before the bridge over the Hurricane river was reached, with the train on a down grade and running at high speed. The apparent cause was a broken axle. Before the train struck the bridge several other cars were derailed, and the trucks wabbled back and forth over the roadbed considerably, never getting very far out, as is not only distinctly stated but conclusively shown by the fact that the bridge proper was passed in safety by the entire train. The bridge was of considerable length; one account says 500 ft., but "the marks of broken axles (more likely, wheels, for the most part) show for several hundred yards on the roadbed and bridge."

Beyond the bridge, however, was 500 to 800 ft. of trestle approach, and as soon as the derailed train struck this it began to go over, but not so rapidly, but that it fell only after passing the first third of the trestle, knocking its apology for a floor all to pieces and demolishing the stretch beyond completely. The engine escaped, but the tender was dragged down with the rest of the train. It appears clear from these facts that the floor was merely the common one of 8 or 9 ft. ties, spaced 2 ft. or so apart, and with no pretense of guard rail. If wrong as to this particular floor, we shall be pleased to do justice to it as conspicuously as possible, when details reach us, but there are thousands of trestles in the South with just exactly that kind of floor, and plenty of them in the North as well. It is such a paltry economy as compared with 12 ft. or 14 ft. ties spaced close together and with heavy outside guard-rails, that for the most part its use comes merely from thoughtlessness and inexperience in operating. We have some drawings in preparation showing how a trestle should be built, which will help to reinforce this moral and until then we pass it.

Even with such a trestle floor, however, the circumstances make it highly probable that good rerailing bridge guards would have put enough of the trucks back on the rails at the entrance of the bridge to have ensured the safety of the train on the trestle, even if a broken axle was in fact the original cause of

the derailment, which is not entirely clear. There has been enough money loss from this accident alone, not to speak of the loss of life, to equip the whole State of Georgia with rerailing guards at every bridge and trestle. We hope and believe that in time these repeated lessons will be heeded.

The Result of the Burlington Strike.

The great Burlington strike seems to be practically over. The Burlington engines are alleged to have been all manned with new crews, and although there are the usual charges of inefficiency, which are no doubt in part justified for the time being, yet a week or two will end that, and all will be going smoothly. The attempts to boycott Burlington cars are still maintained in a half-hearted desultory fashion, but in the main it has been given up as hopeless and illegal. The sympathetic strikes on the Atchison, Topeka & Santa Fé and other lines have likewise come to naught.

If the lesson of the strike be duly appreciated by both sides, it may yet prove to be one of the most profitable strikes which has ever occurred, and in these days of labor troubles it is well for every one to consider what the lesson is. The notable change from the former Brotherhood fashion of conducting strikes is alone highly significant, and we suspect there will be a still more notable change after this one.

Ten or twelve years ago, when the Brotherhood was young, it began an intolerably offensive and injurious style of striking which consisted in stopping all engines and trains at a given moment, wherever they happened to be, by a preconcerted arrangement of which both the public and the railway officials were carefully kept ignorant. The fact that numbers of innocent and helpless passengers, who had no part in, and could exercise no control whatever over the dispute, were thus caused great annoyance and even suffering, was allowed no weight. Strikes of this kind occurred in quick succession, and were at first successful, but so aroused public indignation that the Brotherhood was about to be crushed out with an iron hand by stringent laws when it changed its policy completely, retaining the same leaders, and has since become known as the most conservative and reasonable of labor organizations, and has won great credit and public goodwill therefor. Numerous threatened strikes in which they were in the right, and would have been supported by public opinion, as notably the threatened strike on the New York elevated lines three or four years ago, have been amicably settled and no actual strike of any moment has occurred in this whole period until this latest one.

As nearly as we can ascertain the Burlington engineers had certain well grounded causes of complaint in this last affair. It is alleged and not denied, at any rate, that on an average they were getting 50 cts. to $1.00 a day less pay than 90 per cent. of the other roads in the west were paying for corresponding service. The C. B. & Q. has always been a closely managed corporation, and the alleged contrast in rates of pay would appear not inconsistent with the general policy of its owners. This, if true, was an indefensible injustice. It is always possible for any one employer among a large number to pay a little less than others and keep the ranks full, just as it is possible for some one given class of skilled or unskilled laborers to force their wages up to a higher point than others around them in analogous employments are gaining, by more effective combination, but neither end is defensible nor permanently possible. Firemen are always glad to be promoted, and even without resorting to the shameful practice charged (as we believe without truth), systematically discharging the men at the top to make room for cheaper men at the bottom, by merely allowing men at the top to leave as they saw better opportunities elsewhere, and constantly promoting from below to fill their place, any *one* road can get along very nicely and maintain an efficient staff, while still paying less than its neighbors.

To some extent, we are forced to believe, this is precisely what the C. B. & Q. has been doing, and if so, had the men chosen to continue in what was becoming their traditional policy, and confined their protests to persistent agitation and the collection and presentation of facts, they could unquestionably within a reasonable time have had real grievances redressed. The fear of strikes is a far more effective weapon than the strike itself, and the Brotherhood might even have fixed a date for a strike two or three months ahead, leaving the interim for peaceful negotiation, and still have carried the public with them and carried their point, if they really had one in their favor. Pressure from other roads as well as from public opinion would have been brought to bear to forbid trifling with demands so reasonably and moderately pressed.

This they did not do. After a very moderate amount of negotiation, and hardly any public discussion, they appealed to force at once; because a strike of any kind says, in effect, that they have power to compel concessions anyway, and mean to do so. Hence it inevitably raises a presumption against the reasonableness of the demand with the general public, while as respects the corporate officers, demands made in this way must of necessity be resisted to the bitter end as an act of self-preservation. The result has been complete defeat, when victory might just as well have been obtained as to really well founded claims, if there were in fact any, by a little patience. Arguments must in the long run be met by arguments, and evidence by evidence, or the demands conceded. "Thrice is he armed who hath his quarrel just." But when the "argument" becomes merely that the other side must give in, because they cannot help themselves, it becomes its right and duty to show first that it can help itself, before giving further attention to the merits of the dispute itself, because such forcible methods of settling questions of equity are as contrary to public policy as wars between nations, except as a last resort, and it is better in the end for all parties that those who lightly provoke them should suffer therefor.

And as the world grows more civilized and peaceable they are increasingly likely to do so, as the result in this case goes to prove; a complete defeat of the attacking party when victory would have been made quite certain by a little patience, if there were in fact well grounded causes for complaint, as we judge there were.

If anything may safely be concluded from the past, the lesson will not be lost on the Brotherhood. They should not be condemned because of one partial relapse to methods which they have so long forsaken. They have shown that their tendency is reasonable and peaceable, and it should in justice be added that their manner of conducting this strike, once it was entered on, has been admirable. There have been no attempts at physical violence, and we cannot but believe that they will profit by this failure of a return to moral violence and so adhere still more strongly hereafter to their past peaceful policy, which has won them so much more than violence ever did and the respect of the community besides. Should it be otherwise, or should this strike result in breaking up the most rational labor organization which has ever existed, it will be a public calamity.

The Better Water Supply of Northeastern New Jersey.

The question of a better water supply in that section of New Jersey lying nearest to New York City has been agitated with more or less earnestness since 1876, and considering the importance of wholesome water to this wealthy, populous and otherwise favored region, it is strange that to this time nothing definite has been accomplished.

The very prosperity and rapid growth of the country effected has ruined its old source of supply by sewage contamination and the evil daily grows worse. Eminent medical experts condemn the water of the Passaic and declare it positively dangerous, and yet Newark, Jersey City, Paterson, Passaic and various other towns with a population approaching 500,000 still tap its lower and more or less polluted reaches for their domestic supply.

If this were an unavoidable evil, or all available sources of better water were too distant for utilization, there would be some excuse for the continuance of the present methods. But this is not the case; at least, when the vital importance of pure and wholesome water in the further development of an already rich and rapidly growing region is taken into consideration. The upper waters of the Passaic are still pure, and drain about 750 sq. miles of a mountainous and thinly settled country; and further, this basin is little more removed from the center of distribution than is the Croton water shed from the city of New York.

What is wanted is united action on the part, not only of the cities now taking bad water, but of the numerous flourishing towns which have no public supply at all. Plainfield, for example, has a population of about 12,000 and depends solely upon well water taken from a depth of about 16 ft. below the streets of a populous town; Orange, with over 13,000 inhabitants, also depends upon a surface supply. While this supply may be for a time good enough, it is always liable to suspicion, and this is particularly so when the source of supply is so near the surface that it must in time be contaminated to a more or less dangerous degree by the waste of a considerable population.

Plans are not wanting for bringing the water of the lakes, ponds and upper waters of the Passaic to the houses of consumers, for Prof. COOK, in his report, gives the list of these lakes and ponds, 22 in number, with areas ranging from 4 sq. miles down to 20 acres, and approximate estimates covering the cost of impounding this water and no less than seven distinct plans of conveying it to the towns that need it. Over 300,000,000 galls. daily are now going to waste in freshets, and yet Prof. COOK says that the cost of an abundant supply of pure water would be less than the amount expended on the Croton works when New York had no larger population that the Jersey area which could utilize this water.

As Mr. KENT remarked, in a late address to the Citizens Improvement Association of Passaic, and as this journal has already pointed out, it is certain that within a comparatively short time the North river will be bridged, and perhaps tunneled, and all of this section of New Jersey made more accessible as a means of providing for the over-flowing population of New York. With the slow ferries eliminated and the delays due to ice and fog gone with them, Newark and many other towns

Respectfully S. Whipple

thereabouts will be practically nearer to the business center of New York than Harlem is now. Statistics show that between 1870 and 1880 Jersey City has increased in population 46.3 per cent., Newark has increased 30 per cent. and Paterson 52 per cent. If this growth has taken place under past conditions of communication with the great city of New York, what would be the result of practically reducing the time of transit between them and the metropolis by almost one-half?

In fact, present demands and the promise of the immediate future, mark out this section of our country as one destined to grow more rapidly than it has yet done; and that this growth may be healthy from the start, good water, and plenty of it, is an essential factor. Now that Gov. GREEN, in his late message, has taken official notice of the present needs and has strongly recommended improvement, it is to be earnestly hoped that some definite action will be taken. The interest is a common one to everybody in a large section of the State; for even the man who is outside of the distribution area and is abundantly provided from another and equally good source, yet shares in the general prosperity and better development of the region immediately effected. The people of this part of New Jersey have the water sources, the money to pay for a better supply and the engineers to bring it to their doors; all they lack is a vigorous, united effort to realize a project of which every one recognizes the importance.

Squire Whipple.

(With Portrait.)

SQUIRE WHIPPLE, the son of JAMES WHIPPLE and ELECTA JOHNSON, was born in Hardwick, Mass., Sept. 16, 1804. His father was a farmer and later the owner of a small cotton mill, and the subject of this sketch spent the early period of his life in work connected with the farm and mill. It was to this sturdy training that Mr. WHIPPLE undoubtedly owed much of that vigor of mind and constitution which enabled him to bear so long and gracefully the burden of years. From the age of eight to thirteen he attended the common district school in Hardwick for about six months in the year, and labored the remaining six in his father's cotton factory and upon the farm. In 1817, the father removed to Otsego Co., N. Y. and his son SQUIRE assisted him in farming. After teaching school for a short time, SQUIRE WHIPPLE, from 1822 to 1829, attended the Academical Schools of the district, and in the latter year entered the senior class of Union College, Schenectady, N. Y., and at the expiration of the year graduated with the degree of A. B.

His early training in the machine shops, connected with his father's factory, had materially assisted in developing a natural taste and talent for mechanical pursuits, and after leaving Union College he determined to enter the new and then scarcely defined field of Civil Engineering, towards which the construction of the Erie canal, and some few other public works, had lately attracted his attention.

His first practical experience in his chosen profession was as rodman, and subsequently as a leveller upon the Baltimore & Ohio R. R. in 1830-31. From this time until 1836 he was chiefly occupied in fixing the boundaries of lands necessary for the use and maintenance of the Erie canal, and in surveys and estimates for the Erie canal enlargement, under the late HOLMES HUTCHINSON, of Utica, as Chief Engineer. In 1836-37 he was employed for a few months (until the suspension of the work) on the Eastern Division of the N. Y. & E. R. R. as Resident Engineer, under the late EDWIN F. JOHNSON, of Middletown, Conn. The work enumerated, together with some five or six surveys and estimates (from 1837 to 1850) of railroad and canal routes, constitutes the bulk of Mr. WHIPPLES experience in general field engineering. In the intervals of enforced leisure, Mr. WHIPPLE'S taste for mechanics induced him to turn his attention to the manufacture of engineering field instruments, and some 20 or 25 levelling instruments and several fully equipped transits were the results of this labor.

In 1840 Mr. WHIPPLE designed and constructed a model for a scale for weighing boats of two or three hundred tons; and subsequently built upon the Erie canal the first enlarged weighing lock scale upon that work. The scale worked satisfactorily and served as a model for four or five scales afterwards built by Mr. WHIPPLE and others.

About this same time SQUIRE WHIPPLE designed and obtained letters-patent for his first *iron bridge truss*. Subsequently he built a large number of his patent iron-arch-truss bridges of 70 to 100 ft. span, over the Erie canal. This was the first decidedly successful attempt at the construction and use of iron-truss bridges. The innovation was slow of adoption by the public, however, and though the bridges themselves had practically proven the adaptability of this new material in construction, the public still regarded them with distrust and suspicion; previous to 1850 there were only 30 iron bridges in the country, and the majority of these were built by Mr. WHIPPLE over the Erie canal.

About 1852, Mr. WHIPPLE built several short and unimportant iron railroad bridges upon the N. Y. & E. R. R. These structures were severely tested and in successful use for some months, but were finally removed in deference to a panic caused by the breaking down of an iron bridge on the same line, but of different build and proportions. Another of Mr. WHIPPLE'S railroad bridges, erected near West Troy, N. Y., in the years 1852-53, was only removed in 1882 by the Delaware & Hudson Canal Co.; it was 150 ft. span and of the "Whipple trapezoidal" type; during all the intervening years this bridge had fulfilled in every respect the purpose of its builder, and was finally taken down in the belief that it had grown too weak in some of its parts for modern loads. A full description of this particular bridge will be found from the pen of SQUIRE WHIPPLE himself in ENGINEERING NEWS of April 7, 1883.

In the early part of 1847 Mr. WHIPPLE published a small elementary and practical work upon bridge building, which is remarkable, both for the soundness of its reasoning and as being one of the very earliest treatises upon this subject, based upon correct and scientific principles. The full title of the book was "A work upon Bridge Building, consisting of two Essays, the one Elementary and General, the other giving Original plans and Practical details for Iron and Wooden Bridges;" it was printed in Utica, N. Y., by H. H. CURTISS. Previous to the appearance of this production, the proportions of the several parts of a bridge had been the results of trial and experience rather than the outcome of any study of governing principles. But Mr. WHIPPLE now pointed out and illustrated the fundamental law of framed structures, and gave rules and formulæ for determining the exact maximum strain upon each member of the bridge; he also treated of the relative economy of different combinations and arrangement of the parts of the truss, and in a remarkable degree forecast the actual practice of the best builders of the present day. Among the later "patented" bridge trusses are found some considered and discarded by Mr. WHIPPLE in this very work.

Mr. WHIPPLE did not claim originality for the use of diagonal or oblique members between parallel chords, with or without verticals, but he undoubtedly deserves credit for the exact calculation of strains in the individual members of a bridge, and the proper and economic proportioning of the parts; and also for the adoption of a trapezoidal form of truss with a triangular panel at each end, a design now in very common use and first employed by him.

In 1872 Mr. WHIPPLE published an enlarged edition of his treatise on "Bridge Building," which has had an extensive circulation, a fourth edition being published in 1883. In 1869 SQUIRE WHIPPLE published a continuation of his first book of 1847, commencing the paging where he left off before, or running it from page 121 to 249. In this last work he set the type, made the woodcuts and printed the book on a small hand press at his own home. In 1866 he also published at Albany a pamphlet entitled "The Doctrine of Central Forces, illustrated without the use of the Calculus."

Mr. WHIPPLE'S attention having been called to the seemingly impossible construction of drawbridges over certain awkward points on the Erie canal, in 1872, designed and patented a "lift draw-bridge" to overcome these difficulties. The principal feature in this device was a counter poised floor, suspended from an elevated stationary truss bridge; the floor to be moved vertically by the action of a system of gears and shafting whereby it could be raised to the truss chords for the passage of boats beneath, and lowered to near the water surface for the transit of vehicles. In 1873-4 the inventor built the first of these "lift draw-bridges" over the Erie canal at Utica, N. Y., and it has been in satisfactory use ever since.

In character, the subject of this memoir was genial but retiring in his disposition, and while by no means averse to the society of congenial spirits, found a large share of his enjoyment in quiet study and mechanical experiments.

From boyhood he discarded the use of animal food of all kinds save the products of the dairy, and did this mainly from a long cherished aversion to violence, and what he regarded as cruelty to the dumb creation. In a small work privately printed in 1847, and entitled. "The Way to Happiness, being an essay on the motives to human actions, and the fundamental principles of morality," he ably defends and recommends his peculiar system of diet as being favorable to good health, rational economy, and sound morality. His own vigorous old age, and the fact that he was the last of a family of ten children, would seem to prove that he certainly found virtue in his convictions.

Mr. WHIPPLE was made an Honorary Member of the American Society Civil Engineers on May 6, 1868. He died at his home in Albany, N. Y. on March 15, leaving a widow but no children.

PERSONAL.

HENRY SNYDER was appointed on March 3 General Manager of the Union Switch & Signal Co., vice C. R. JOHNSON, resigned.

P. C. POULSON, formerly of the Maintenance Dept., Long Island R. R., has been appointed Roadmaster of Division No. 4, with headquarters at Babylon, L. I.

R. C. VILAS has been elected President of the Eames Vacuum Brake Co., New York.

THOS. L. KIMBALL succeeds the late T. J. POTTER as Vice-President and General Manager of the Union Pacific Ry.

J. T. JONES has been appointed Master Mechanic of the St. Louis, Wichita & Western Ry., with headquarters at Fort Scott, Kan.

G. N. MILLER, of St. Paul, Minn., has been appointed to prepare plans for a sewerage system at Helena, Mont., for $1,500.

M. WINGELAND has been elected City Engineer of Sioux City, Ia.

M. ERWIN, Superintendent of the Chicago Division of the Chicago, St. Paul & Kansas City R. R., with headquarters at Dubuque, Ia., has resigned and the office will be abolished.

E. H. GOODMAN, who was connected for 18 years with the Pullman's Palace Car Co., and since August, 1886, had been Second Vice-President, was appointed, on March 12, Assistant General Manager and General Agent of the Union Switch & Signal Co., GEO. WESTINGHOUSE, Jr., President.

CORRESPONDENCE.

Strains in Pins.

COLUMBUS, O., March 6, 1888.

EDITOR ENGINEERING NEWS:

Some few weeks since there appeared in your columns an item in regard to pins, which was sent in as being of interest and was not intended as a criticism on any one's calculations.

The fact of such excessive strain is no matter of news, and it was only on account of the great variance in results, that they were published.

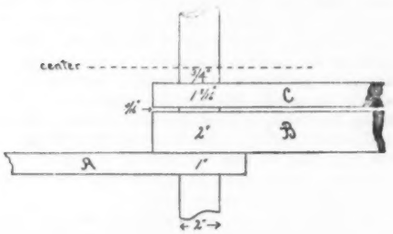
They showed very conclusively that some one was not using or at least making strict application of the method which Prof. JOHNSON chooses to call the "best practice" but should rather be called the "prevalent practice."

In Prof. JOHNSON'S discussion of the matter, he states that in his opinion pins can be as exactly calculated as any other part of a bridge, but concludes his remarks by trying to explain why the result, no matter how exact, does not exactly apply to the case in question. And this was the point raised in my for-

mer note; when you have made your exact calculation, does it exactly apply?

Mr. OSBORNE'S calculation in your issue of Feb. 18 is only one of many similar cases that have come to my notice, and the method used is the one by which I have arrived at similar results, but have never regarded the results as applicable. *The most conclusive proof of the matter of incorrectness or inapplicability is the result itself, for no material would stand the strain for an instant.* The material which usually undergoes such strain (?) is always found, when the bridge is taken down, to have suffered no deformation, and is not always of the best material.

In connection with Mr. OSBORNE'S calculation it would be interesting to know, if, on finding all other



parts of a bridge to be abundantly strong, he would condemn the bridge on account of the pins calculating light, for simple bending moment alone.

Since this matter came up I find in looking over some old pin calculations which are at hand, one which is in one respect at least very interesting, in that, the only way there seems to be to calculate it, is by simple bending moment.

Piece	Strain	Shear	Lever arm	Moment	Sum
A	+ 37800	+ 37800	1" .563	59081	
B	− 20540	+ 17260	1" .780	30723	89804
C	− 17260				
	$\frac{nd^3}{32}$ =.785				

89804 ÷ .785 = 114400 pound sq. in.

when the structure was taken down, the pins were found to be uninjured, with the exception of some of them being crystalline, and whether this was the result of wear, there was no means of telling, as no record was kept of any tests of materials at the time of erection.

Whether the pin stood up, on account of bending giving relief to the bar "C" or whether it was due, as suggested in my former note, to the bars being packed and retained by a nut, must be somewhat uncertain, but from the arrangement (not shown in cut) it is hardly possible to relieve "C."

Taking the most favorable view, in supposing "B" to carry the whole strain, we would still have about 75,000 lbs. fiber strain. And in any case, the strain is still so excessive, as to make it appear that there is something in the reference given from STONEY, noted in my former note.

Very truly yours, C. E. FOWLER.

Curved and Straight Dams.

PHILADELPHIA, Pa., March 10, 1888.

EDITOR ENGINEERING NEWS:

In to-day's issue you kindly published my letter concerning the design of the Quaker Bridge dam, remarking that you "are at a loss to understand how it can be demonstrated that a curved dam would be 100 per cent. or any other specific per cent. stronger than a straight one." I suppose you will be pleased to have some explanation on that point.

I do not remember to have said anywhere that *a* curved dam would be 100 per cent. stronger than *a* straight one. I spoke exclusively about the *Quaker Bridge* dam built on a *curve of 900 ft. radius.*

The main objections to this form was that the curved dam would produce an excessive pressure (46.8 tons per sq. ft.) on the voussoir joints. (See articles in ENGINEERING NEWS, Jan. 14, and 28, under head of "High Masonry Dam.") should it act as an arch. If the mathematical demonstration of the excessive pressure is correct, the following phenomenon must take place: Suppose the curved dam constructed and a spring scale placed between the abutments and the dam itself. If a mass pushes against the extrados with a force of 50 lbs., for instance, the spring scale should register 50×900 =45,000 lbs.

Nobody, I am sure, would admit this absurdity; still it is the exact translation of the formula used in calculating the excessive pressure of 46.8 tons.

Unless the force applied to the estrados is *greater* than the frictional resistance of the wall, or, unless the moment of said force is *greater* than the moment of resistance produced by the weight of the wall, *no force can be transmitted to the abutment.*

No matter how thin the section of the wall may be, there will be *some resistance* to overcome before the dam could act as an arch.

Knowing the frictional and the leverage reistance the proposed profile of the Quaker Bridge dam, it an be easily found that the static pressure of the ater should be DOUBLED to allow 16.63 tons (limit dopted in the gravity dam) to be sustained by the voussoir joint. Hence, my expression of 100 per cent. increase of stability.

I have next to prove that the above calculation is as fair as any one made on the stability of the gravity dam.

To be able to compare the relative stability of both plans, I must necessarily use similar methods in both cases, and I did so.

1. I have used the very same limit for crushing strain, 16.63 tons per sq. ft.

2. I did not consider anything else but the *static* pressure of the water, as it has been done for the gravity dam.

3. There are "incomputable" forces acting on a straight dam as well as on a curved one, hence the co-efficient of safety = $\frac{\text{crushing strength}}{16.63}$ as adopted for the gravity dam.

You say that the increase of stability would be "much more than 100 per cent. in case of an emergency like an earthquake." My paper, referred to in my letter of March 3, did not consider the case of an earthquake. I am unable to say what would become the stability of the curved dam in such an emergency.

As to the "consolidation of the mass" it should be remembered that said consolidation cannot take place without a sliding motion of the stones; that said motion can only occur after the frictional resistance of the material and the adhesive power of the mortar will have been overcome; that the force which could possibly overcome said resistance must be certainly nearly double the static pressure of the water, and that said force is limited by the consideration that it should not transmit to the abutments more than 16.63 tons per sq. ft., which case has already been considered above. The reasons for which I favor the curved plan are as follows:

1. It would be much more expensive to make the profile of the straight dam as strong as the curved dam.

2. The profile as proposed, is not strong enough to resist by gravity alone. It is only safe enough to resist the *static* pressure of the water. It should be remembered that the dam *has to stop suddenly the current* of the water in freshets, and to do so it requires an immense force which cannot be calculated To build the straight dam would be equivalent to an experiment, in order to find out whether or not it would stand, and the Quaker Bridge dam is not certainly the one to select to make such experiments.

3. The curved dam has a better appearance.

Yours respectfully, P. MARICHAL, C. E.
Phila. Water Dept.

[Our correspondent hardly seems to allow for the fact that such a dam must have of necessity a very considerable and more or less irregular elastic movement under pressure, and in various other points we should be disposed to differ from the positions stated, while we agree fully with the main conclusion that the curved form is so much the better as to be the only proper one. But as we have stated fully our own reasons for this conclusion, and our correspondent has stated his, it appears unnecessary to reopen the discussion as to details.—ED. ENG. NEWS.]

City Lighting.

CHAMPAIGN, Ill., March 9, 1888.

EDITOR ENGINEERING NEWS:

Will you please tell me of a good treatise on "City Lighting?" I do not want an elaborate work, but a short treatise as to the cost and best means, apparatus, etc. Yours respectfully,

P. A. SCHAEFER.

[If our correspondent desires a treatise upon the comparative cost of the various systems of street lighting, by gas, electricity or oil, we know of no such work treating the subject generally. Nearly every one of our large cities, however, has made comparative estimates of cost of gas and electricity and the results have been published in city reports; but this testimony is somewhat conflicting and not always unbiased. Gas has so long held supreme sway and electricity is comparatively so new as a public illuminant, that the work desired by Mr. SCHAEFER is yet to be written, as we understand his query.—ED. ENG. NEWS].

Lime with Rosendale Cement.

ELMIRA, N. Y., March 15, 1888.

EDITOR ENGINEERING NEWS:

I noticed in your last edition of the NEWS an opinion of Prof. IRA O. BAKER of the Illinois University, wherein he recommends the use of lime with Rosendale cement. Will you kindly advise me in the next issue of your paper, if possible, the proportion of lime and sand to use with Rosendale cement for a cellar bottom. Yours respectfully,

JAMES H. COSTELLO
of The Elmira Sewer Pipe Co.

[We must refer our correspondent to Prof. BAKER or to others who have more practical experience than ourselves in the combination referred to.—ED. ENG. NEWS.]

Stone Working and Quarrying Machinery.

A.,T. & S. Fé R. R. Co.; Bridge & Bldg. Dept.,
COLORADO SPRINGS, Col., March 16, 1888.

EDITOR ENGINEERING NEWS:

I am desirous of learning something about a Channelling Machine used in quarrying stone. Do you know where such a machine can be got and what the price will be? I have carefully watched your advertising columns hoping to see something of this kind but without success. Can you not drum up a few good advertisements of stone working and quarrying machinery. Yours truly,

M. J. BUTLER.

Nomenclature of Cements.

NEW YORK, March 20, 1888.

EDITOR ENGINEERING NEWS:

In your issue of the 17th Inst. Prof. IRA O. BAKER suggests that engineers adopt in their specifications for "that other cement" commonly styled American, domestic or hydraulic, the use of the word "Rosendale" prefixed by the name of the place where it is manufactured and exemplifies it as Milwaukee-Rosendale, Louisville-Rosendale, or Ulster Co. Rosendale.

Inasmuch as the district in the State of New York where Rosendale cement has been manufactured since 1828 has given a commercial value to the use of the term "Rosendale" it would be impolitic to permit its use by manufacturers outside that region. Quite recently some Pennsylvania makers in their efforts to sell their product, labelled it "Rosendale" and were promptly restrained by the New York manufacturers.

Specifications can read Louisville, Milwaukee, Utica or Rosendale cement, and engineers should require and make analyses of the cements in addition to a test for tensile strength, neat and with sand, and only accept the most suitable quality for

which it is required. Analysis determines if cement has been properly manufactured.

This opportunity permits me to correct an inadvertency of your correspondent that Portland cement received its name from being first made on the isle of Portland, off the south coast of England. The first true Portland cement was made at Northfleet, Kent, and received its name from resembling, when made into blocks, the famous Portland building stone quarried in the isle of Portland.

Yours truly, HOWARD FLEMING.

[In justice to Mr. BAKER, in connection with Mr. FLEMING'S remarks on the origin of the name of Portland cement, we should state that Prof. BAKER in a later letter corrected his first definition to practically the same as stated above; but thanks to the "blizzard" of last week, the editor in whose hands this letter remained did not appear in time to make the desired correction.—ED. ENG. NEWS.]

Taking Topography.

Balt. & Drum Point R. R. Engineer's Office.
ANNAPOLIS, MD., March 7, 1888.

EDITOR ENGINEERING NEWS:

I notice a very amusing communication, in your issue of March 3, from Mr. EUGENE RICKSECKER, giving an adverse criticism of Mr. WELLINGTON'S definition of topography and asserting that a topographer should take "8 or 10 miles of topography a day." I have had a few years experience in this branch of business, continually since 1872, and have egotism enough to assert that neither Mr. RICKSECKER, nor any one else in the U. S. Geological Survey, can take ten miles of topography a day that would be of any practical use, for any purpose. If Mr. RICKSECKSER can take 8 miles of reliable topography a day, his services should be so continually sought after as to interfere with his possibility of getting much sleep. Yours truly.

U. S. LUTZ.

ENGINEERING NEWS.

THE upper dam at Exeter Pond, Lebanon, Conn., was washed away March 17, the flood doing considerable damage. Six bridges have been swept away by floods in Connecticut. The ice in the Missouri and other western rivers is breaking up, and several bridges and trestles have been washed away or damaged in Nebraska and Montana.

WE have kept a tally of nineteen instances in which locomotives were derailed in the late storm, when being butted into snow banks, with more or less wreckage. This list does not pretend to be exhaustive, and we have no doubt there were at least as many more.

KANSAS CITY is discussing underground conduits for its electric wires, and an ordinance is now before its councils granting a franchise to L. R. MOORE, J. FOSTER RHODES and H. P. CHURCHILL for the construction of such a system. By the wording of this franchise all excavations are to be made under the direction of the City Engineer, and the streets are to be restored to exactly the same condition as found; a bond of $20,000 is to be given the city.

MESSRS. ONDERDONK & CO., the contractors for the new Lake tunnel, are now drifting for the land sections in two directions from the shore shaft; the south drift is out 30 ft. and the men are making steady progress. The west drift is more difficult as the clay has been softened by the water near the shaft and 4 ft. have only been made in 3 days.

ST. PETERSBURG reports have it that Gen. KOMAROFF is engaged in developing a project for the extension of the Trans-Caspian railway to Meshed, in Khorassan. This city is commercially more important than Herat and almost as important strategically. The line could be built in a year as the ground is almost prepared for it by the military road which Russia has built across the Persian frontier.

THE Union Switch and Signal Co. announces a new departure in the supply of interlocking and signalling apparatus. Instead of furnishing both the material and labor necessary for erection, it now proposes to supply the material and superintendence only, leaving the purchasers to provide their own labor. This plan makes the plant cheaper for the railroad company in first cost.

MAYOR ROCHE and Commissioner SWIFT of Chicago are attempting to enforce old city ordinances, requiring at least six of the railway companies entering that city to build two viaducts yearly over the principal crossings. These ordinances have not been observed for 10 years and the city has thus lost 12 viaducts yearly. Meetings are now being held with the companies, and the prospects are good for considerable work in this direction.

NEXT to the accident on the Savannah, Florida & Western Railway, the most serious accident of the week was the derailment of a passenger train on the Delaware, Lackawanna & Western Railroad near Vestal, N. Y., on March 16. The train was running at a rapid rate of speed when 2 cars left the track and after running a short distance went over a 20 ft. bank, taking 2 other cars with them, only the engine and baggage car remaining on the rails. The wreck caught fire from an overturned stove in the day car and was consumed, but fortunately all the passengers were got out. One person was killed and a number seriously injured. The accident is attributed to a broken wheel or axle.

IN our last issue the fact was mentioned that the "blizzard" delayed travel for only 36 hours on the elevated roads of this city, and the management was congratulated upon this comparatively short stoppage of traffic. It is only just to remark now that the Suburban Rapid Transit line should not have been included in the list given, for that road *did not suspend travel a single hour.* In fact, to the best of our belief, it was the only steam railroad in uninterrupted operation over an area covering some 40,000 sq. miles of territory. On Monday afternoon and evening the intervals between trains were lengthened to about 15 minutes, but during the rest of the time the regular 5 and 6 minute intervals were maintained. This record reflects the greatest credit upon the management, and may be said to have been especially due to the vigor and efficiency shown by Superintendent E. B. WETMORE. The line in question operates 2¼ miles of double track and runs 200 trains each way daily. The rigid and strong character of the structure and the powerful engines used had much to do with the unbroken maintenance of traffic.

SOME tall swearing in regard to the Arthur Kill or Staten Island bridge, has been done this week before the Board of Engineers appointed by the War Department. On the part of the Pennsylvania and the Lehigh Valley it was claimed that 10,000,000 tons per annum now went through there at a 5 cent towing rate which would surely be raised to 7 cents, and so cost $420,000 annually. A petition of 125 captains, engineers and pilots in opposition was also claimed. On the other side it was alleged that of these signers 56 were not employed on the Sound at all, and 68 were Pennsylvania employés, and that the only possible difficulty would be in handling the enormous rafts of canal boats which are not towed at all, but simply drift with the tide, and ought to be stopped anyway as dangerous to legitimate navigation. The Board has gone to see for itself, and will afterwards report.

SOCIETY PROCEEDINGS.

American Society of Civil Engineers.—The regular meeting was held March 21, Treasurer, GEO. S. GREENE, Jr., in the chair. A description by EDWARD PRINCE of "A 30-in. Wooden Conduit Designed and Constructed for the Quincy (Ill.) Water-Works" was read by the Secretary. The conduit is to convey water from a crib 1,480 ft. out in the Mississippi river to the iron pipe leading to the pump well. It was launched in 3 sections, 540, 548 and 400 ft. long, which were towed into place, joined together, ballasted and sunk. The information was very brief, and a number of questions were asked which were noted by the Secretary, who will request replies from Mr. PRINCE in order to obtain a more detailed account of what appears to be a very interesting piece of work. A circular issued by the Department of Agriculture, relating to proper times of cutting and methods of handling timber, as well as the comparative durability of different species of timber was read and discussed.

With regard to the sizes of sewers, particulars as to which were requested at the time of the publication of Mr. MCMATH'S paper on "Determination of the Size of Sewers," in April last, a translation by Mr. KUICHLING, of a description of a sewer at Dresden was read. Mr. HERING referred to experiments now being made in New York on the flow in sewers, and to similar experiments at Washington and Philadelphia. Mr. BRINCKERHOFF mentioned a case in Brooklyn where the water forced off iron manhole covers, flooded streets and burst the sewer in some places.

The Secretary announced the death of SQUIRE WHIPPLE, Hon. M. Am. Soc. C. E., (elected in 1868) and Mr. THEODORE COOPER made some very well chosen and interesting remarks on the importance to American bridge practice of Mr. WHIPPLE'S work with regard to the proper design and construction of bridges on scientific principles. The original model used by Mr. WHIPPLE is in the possession of the Society. Attention was called to a book on bridge designing published in 1847 by Mr. WHIPPLE, the type setting of which he did himself, and it was proposed to print a facsimile of the book to accompany the usual memoir, as it was thought it would be read with interest by many engineers who have not the opportunity of seeing the original in the library. The meeting then adjourned.

Western Society of Engineers.—The 245th regular meeting was held at Chicago, March 6; President A. GOTTLIEB in the chair. The following were elected Members: CHARLES B. PARSONS, Englewood, Ill.; S. LEE HEIDENREICH, Chicago; ROBERT A. SHAILER, Chicago.

Letter ballots were canvassed for the following amendments to the By Laws.

Section 1.—The entrance fee shall be $5; said amount to accompany each application for admission, and to be returned if applicant is rejected.

Section 2.—Members residing in Cook county shall pay dues at the rate of $8.50 per year; all other members of every grade shall pay at the rate of $7.50 per annum.

The amendments were adopted, the extra dues to be collected when ordered by the Society.

The Special Committee appointed to consider the question of "Better Provision for Rainfall Observation by the Signal Service," reported as follows:

Your Committee to whom was referred a request from a Committee of the American Society of Civil Engineers, for the Western Society of Engineers to join in a petition to Congress in regard to Rainfall Observations by the Signal Service Bureau, submits the following resolution for adoption by the Society:

WHEREAS, It is deemed highly desirable by the engineering profession that better information should be collected, than is now available, regarding the intensity of rainfalls in different sections of the United States, particularly with reference to the practical questions involved in the construction of works for water supply and sewerage, and

WHEREAS, It is entirely feasible for the Signal Service Bureau to obtain such information without increase of force, but simply by erection of automatic, self-registering rain gauges in addition to those now employed; therefore be it

Resolved, That the Western Society of Engineers respectfully urges upon Congress the desirability of inserting in the next annual appropriation bill for the Signal Service Bureau, an item sufficient to cover the expense of placing automatic rain gauges at all principal stations, as the Chief Signal Officer may direct.

Your committee recommend that a copy be sent to the committee of the American Society having the matter in charge. Signed

B. WILLIAMS,
CHAS. MACRITCHIE,
L. E. COOLEY,
Committee.

The resolution was adopted, the recommendation approved and the committee discharged.

The Special Committee on "Specifications for Highway Bridges," reported as follows:—

The committee to whom has been referred, Mr. J. A. L. WADDELL'S communication in reference to his "General Specifications for Highway Bridges," respectfully reports as follows:

We think that improvement in the character of highway bridges, as now built, is much needed.

We do not consider that an association of bridge builders, as outlined and advocated by Mr. WADDELL, is feasible, or would accomplish the results desired.

We do not consider it to be the province of this Society to recommend the adoption of the specifications of any individual.

We think that improvement in the character of highway bridges can be brought about by the following means:

The governor of each State to appoint an engineer, whose duty it will be to examine and report on existing bridges, with authority to condemn unsafe structures, and to act as expert adviser to the Legislature on all questions and measures pertaining to the construction of new work.

Cities and counties should be encouraged to employ engineers, who are bridge specialists, to prepare specifications and complete detail plans for bridges, and tenders from contractors should be received on the basis of these specifications and plans. In order to facilitate the adoption of this method, we think it highly desirable that engineers agree upon a scale of minimum rates for doing such work on a similar plan to that in vogue among architects.

Respectfully submitted. Signed

C. L. STROBEL,
E. C. CARTER,
A. GOTTLIEB,

The report of the committee was adopted as the sense of the Society. After considerable discussion the committee was continued, with instructions to report at the next meeting the best practical means for carrying their suggestions into effect.

There seemed to be a unanimity of sentiment in regard to the desirability of some regulation or standard of fee practice and the establishment of a code of ethics for the profession, and that the suggestions of the committee were a step in the right direction.

Mr. COOLEY, for the Committee on National Public Works, stated that the report upon proposed legislation, by the Executive Board of the Council of Engineering Societies on National Public Works, would be issued in a few days, and a copy sent to each member of the Society, and that the subject would be laid before the Society at the first opportunity.

After some general discussion the meeting adjourned.

L. E. COOLEY, *Secretary.*

Liverpool Engineering Society.—The fifth meeting of the current session was held March 7th; Mr. C. H. DARBISHIRE, A. M. Inst. C. E., president in the chair. Mr. J. H. T. TURNER, A. M. Inst. C. E., read a paper entitled "Filtration of Sewage," dealing with some aspects of the question of sewage irrigation as practised in this country and abroad. After reviewing the subject of the pollution of streams by sewage, he considered the various methods adopted to defecate sewage so as to render it admissable into streams. Coming to the question of cleansing sewage by passing it through land, he criticised the prevailing practice in England, and concluded that a frequent cause of the ill success attending sewage farms arose from (1) the small area in proportion to the sewage to be disposed of; (2) the heavy burden imposed upon the farms by the elaborate system of under drainage necessitated by the small area in use; and (3) from the variable nature of the sewage, owing to combining the storm water with the sewage proper.

CONSTRUCTION NEWS.

RAILROADS.

East of Chicago.

Existing Roads.

Lehigh & Eastern.—The Lehigh & Eastern Railroad was sold at Wilkesbarre, Pa., on March 17, to a syndicate of Philadelphia, Sunbury, and Harrisburg capitalists, represented by SILAS V. NEWBERGER of Lehigh county. The purchase of this railroad by the syndicate mentioned means the construction of a road from Sunbury, Northumberland county, eastward, across that county and southern Luzerne county to Hazleton, thence to the Delaware Valley at Stroudsburg and up that valley to Port Jervis, N. Y., a distance of 120 miles.—N. Y. *Times.*

New York, Providence & Boston.—This company has asked the Rhode Island legislature for leave to build extensive freight transfer tracks at Providence, and a drawbridge over the Providence river.

Dayton, Fort Wayne & Chicago.—Judge Elliott has finally appointed R. D. MARSHALL, Receiver of this company. Nearly all the employés of the company had refused to work longer without some assurance of payment and the train service was almost abandoned. The Receiver appointed J. E. GRINPERLING, General Manager, and assured the employés that their wages would be paid and the road would be put into safe condition at once.

Canadian Pacific.—President GEO. STEPHEN says the report that the company had abandoned all its projected extensions in New Brunswick and Nova Scotia is a complete fabrication. The company has 4,000 men now at work on the line to Mattawamkeag, and the section from Fredericton to Salisbury will be built during the coming summer.

Marietta, Columbus & Lake Erie.—President W. P. CUTLER, of Marietta, has agreed to build the extension to Washington C. H., Ohio, for a subsidy of $75,000 and the free right of way. There is little doubt that this sum can be raised and the line will be built this year. The survey is in progress from Kingston west.

New York & Massachusetts.—The latest move of the Poughkeepsie bridge syndicate to prevent this company from obtaining a share of the business from the Poughkeepsie bridge east, is the introduction of a bill amending the bridge charter so as to exclude the New York & Massachusetts railroad from connecting with the bridge. The company is making a sharp fight for its rights, and by the recent decision of the Court of Appeals seems to have a good prospect of securing them.

New York, Chicago & St. Louis.—This line will build a 6 mile extension to Findlay, O., as soon as spring opens.——It has been reported that the Delaware, Lackawanna & Western company has been trying to make arrangements for forwarding passenger traffic over this road to Chicago.

Lehigh Valley.—The directors have voted to issue about $6,750,000 additional stock, the first option for which is secured to their own stockholders. This large stock issue it is thought can hardly be required for the Jersey City extension and it is considered probable that it signalizes the decision of the directors to build the Buffalo & Geneva railroad for which surveys were made last fall.

New Projects and Surveys.

Battle Creek & Bay City.—

BATTLE CREEK, Mich., March 13, 1888.

EDITOR ENGINEERING NEWS:

The preliminary survey is just about to be begun of this line which is to run from Battle Creek, Mich., to Bay City, about 130 miles. A. W. WRIGHT of Alma, Mich., is President, and W. L. BRIGDEN, of Battle Creek, is Chief Engineer.

STEVEN S. HURLBURT, *Secretary.*

Seymour & Southwestern.—

SEYMOUR, Indiana, March 19, 1888.

EDITOR ENGINEERING NEWS:

The Seymour & Southwestern Railway is to run from Seymour, Ind., *via* Brownstown, Vallonia, Bano, Orleans, French Lick, Hillham, and Knoxville, to Jasper about 70 miles. F. M. SWOPE is President and E. S. BLISH is Chief Engineer.

LOUIS SCHNECK, *Secretary.*

Chicago, Lodi & Southeastern.

ROCKVILLE, Ind., March 16, 1888.

EDITOR ENGINEERING NEWS:

In regard to the Chicago, Lodi & Southeastern Ry. Co., I will say, a new board of directors was elected on March 13, and I am not now President Maj. JOHN J. SAFELY, is now President. His address is Waterman, Parke Co., Indiana. If the road is built he is the man who will build it. THOS. N. RICE.

Garnerville.—This line is to be built in the upper part of Rockland county, N. Y., from the terminus of the New Jersey & New York Railroad to a junction with the West Shore road at West Haverstraw. A map of the line has been filed in the County Clerk's office, and notices have been served on the owners of property over which it will pass. JOHN TAYLOR, Superintendent of the Print Works at Garnerville, is President of the company.

Pittsburg, Akron & Western.—This long delayed railroad enterprise, which is projected to run from Akron, O., west to Delphos, about 160 miles, is to be taken up anew this spring. WM. A. LYNCH, of Canton O., the chief mover in the enterprise has succeeded in securing a general extension of the grants of right of way, and it is reported that he has obtained some capital toward building the line.

Lancaster & New Holland.—The Board of Trade of Lancaster, Pa., is interesting itself in this proposed line, and are anxious to push the construction this season. ROBERT J. HOUSTON, of Lancaster, is chairman of the railroad committee.

Rockport, Boonville & Princeton.—Incorporated in Indiana to build a line from Rockport, Spencer Co., to Boonville, Warrick Co., about 50 miles. THOS. R. HARDY, of Rockport, is President.

Rome & Carthage.—The committee who are obtaining subscriptions to the stock of this New York company have only about $12,000 to raise to complete the $70,000 required to organize the company and file articles of incorporation. A. C. KESSINGER of Rome is interested.

SOUTHERN

Existing Roads

Norfolk & Western.—We have frequently referred to the remarkable prosperity of the Norfolk & Western system, and the wide awake and pushing policy which is characteristic of its present management. Another evidence of this is before us in a journal entitled "Virginia, from Norfolk to Bristol" published by the Passenger department of the Norfolk & Western for distribution in the North and East, and especially devoted to the agricultural and mineral resources of the Old Dominion. There is no doubt that the rapid development of the Northwest has been largely due to the policy of wholesale advertising which the railroad companies of that section have pursued. The rich soils and valuable minerals of Virginia deserve to be more widely known than they have been, and the liberal policy of the Norfolk & Western cannot fail to result in great benefit to itself and to the State.

Atlanta & Florida.—

ATLANTA, Ga., March 14, 1888.

EDITOR ENGINEERING NEWS:

The Atlanta & Florida Railroad has 51 miles of track down, 100 miles of roadbed graded, and steel rails and cross ties are on hand sufficient to finish the first division, Atlanta to Fort Valley. The location of the line south of Fort Valley to Florida will be started inside of 60 days. JOHN N. DUNN, *President.*

Savannah, Macon & Dublin.—It is reported that the division between Macon and Dublin is to be completed at an early date, under a separate charter. President ALEXANDER of the Central R. R. of Georgia states that friends of his company have secured an interest in the Savannah, Macon & Dublin. If so, a part of it may be completed in the Central interest.

Central R. R. of Georgia.—Grading on the Buena Vista & Columbus line will begin within 60 days. As soon as surveys and estimates can be completed on the lines from Eden westward, the contracts will be let and it is hoped that some work can be done on the line this year.

Georgia Pacific.—The officers of the company have been examining the surveyed route for the extension from Starkville to Johnsonville, Miss. There is a fair probability that the line will be built this season.

Tuscaloosa Northern.—Grading on the first division of 10 miles will be completed by March 10.

East Tennessee, Virginia & Georgia.—The survey of the cut off from near Jesup, Ga., to Jacksonville, Fla., has been completed. It is stated that the line will enter Jacksonville over the tracks of the Florida Ry. and Navigation Co.

Tennessee Midland.—The city of Nashville has finally raised the $200,000 subsidy asked by the company.

Ohio Valley.—The company proposes an extension to Nashville, and will ask a subsidy of $250,000.

Nashville & Knoxville.—Tracklaying is in progress on this Tennessee road, and the line will be completed from Lebanon to Carthage by June 1.

Savannah, Florida & Western.—Tracklaying is in progress on the extension from Thomasville, Ga., to Tallahassee, Fla., and about 7 miles are completed.

South Carolina.—The report of earnings by the railroads of the State for the month of January, shows that every road made an increase over the same period of last year. The total earnings for January, 1887, were $590,000, and for January, 1888, $705,500.

Georgia, Carolina & Northern.—The 50-mile division between Monroe and Chester, S. C., is nearly graded, and contracts will soon be let for the divisions from Chester, west.

New Projects and Surveys.

Mobile, Hattiesburgh & Jackson.—

MOBILE, Ala., March 15, 1888.

EDITOR ENGINEERING NEWS:

This line was placed under survey March 1, and is to run from Mobile, Ala., to Jackson, Miss., about 175 miles. Right of way is being secured, and contracts will probably be let by Nov. 1, 1888. There is one short bridge over the Pascagoula river, and there will be little stone work and no tunnels. The enterprise is in the interest of the Queen & Crescent system. Dr. O. F. CAWTHORN, of Mobile, Ala., is President and S. D. BROWN, of Mobile, is Chief Engineer.

H. AUSTELL, *General Manager.*

Marion, Princeton & Ohio River.—The location is completed from Marion, Ky., to a point opposite Elizabethtown, Ill. The Ohio Valley Company has offered to furnish steel and rolling stock if the company will build the line ready for the rails.

Belmont & Harpeth River.—This company has been organized at Nashville, Tenn., to build a short dummy line. E. W. COLE is interested.

Danville.—This company has asked for a charter from the Kentucky Legislature to build a road from Danville to the Louisville & Nashville. J. W. YERKES, J. W. PROCTOR, and others are interested.

Pioneer & Ohio River.—Incorporated by A. L. MAXWELL and others of Knoxville, Tenn., to build a road from Chitwood on the Cincinnati Southern Railroad to Cumberland Gap.

Atlanta & Alabama.—The projectors of this Georgia enterprise report good success in raising funds for their work along the proposed line, but very poor success in any attempt to obtain capital in Atlanta.

Memphis, Oxford & Columbus.—The projectors of this enterprise are trying to raise $150,000 in Memphis. W. R. CRUMPTON, President of the Construction Company, agrees to build the line from Memphis to Oxford, Miss., if this amount is secured.

Selma & Greenville.—A road is projected between these Alabama towns. A. P. YOUNG, of Selma, is interested.

Moulton Heights.—A stock company is being formed at Decatur, Ala., by W. D. FOREST, to build a short line to Moulton Heights.

THE NORTHWEST.

Existing Roads.

St. Louis, Carbondale, Metropolis & Paducah.—This defunct Illinois company which graded 25 miles from Metropolis to Vienna in 1885, is the cause of a suit brought in the United States Courts, in which one of the original projectors seeks to recover his share of the profits of the enterprise from the estate of his partner. Railroad enterprises in southern Illinois seem to be generally founded on an airy basis. The Kaskaskia, St. Elmo & Southern, which succeeded the above company, seems to have followed its predecessors into oblivion.

Illinois Central.—Mr. F. A. HILL, of Sioux City, Ia., has been put in charge of all construction of the Illinois Central system in Iowa.

St. Louis & Chicago.—The extension to East St. Louis from Litchfield is making good progress. Tracklaying between Litchfield and Mt. Olive is nearly com-

pleted, and grading is in progress from Mt. Olive to Edwardsville, 22 miles. From this point to East St. Louis trains will run over the Toledo, St. Louis & Kansas City.

St. Paul & Duluth.—Many of the common stockholders of this road are opposed to the extension from St. Paul to Omaha and will fight it in the courts. They are willing that the extension should be built by a separate company, but opposed to imperiling their prospect of future dividends by any pledging of the St. Paul & Duluth Company's credit in aid of the work.

Wisconsin Central.—The contract for 15 miles of the extension from Marshfield west has been let to W. H. UPHAM. It is thought that eventually the line may be extended to Chippewa Falls.

Minneapolis & St. Louis.—It is reported that the Wisconsin, Minnesota & Pacific division, extending from Minneapolis to Watertown, Dak., 223 miles, is to be transferred to the Chicago & Northwestern system.

Manitoba.—The question of the policy of the Dominion Government in regard to the building of railways in the northwest is occupying all the attention of the officials at Ottawa. The Canadian Pacific is said to ask $11,000,000 as compensation for the relinquishment of its monopoly. There is great opposition to the payment of any such sum, and also to the relinquishment of the policy of confining the Northwest to an outlet in Canadian ports. At the same time the certainty of a rebellion in Manitoba, in case the disallowance policy is kept up, confronts the Government.

The Winnipeg *Free Press* says:

"If it should transpire that representatives of the province after all have been decoyed to Ottawa only to be bamboozled and humbugged words cannot describe the folly of the Dominion Government nor the outrageous nature of the insult heaped upon a people and a province. What is coming next it is as yet impossible to say. The situation is more serious than ever before. In any event the railway will be built, and if the near future is pregnant with disaster Manitoba cannot be reproached with not having done all in her power to procure a peaceful arrangement of her difficulties."

The promoters of several large projects for the development of the Northwest, the Winnipeg & North Pacific, the Great Northwest Central, the Manitoba & Northwestern, and others, are waiting the decision of the Government, and if the Canadian Pacific monopoly is to be continued, their chance for early construction will be greatly diminished.

New Projects and Surveys.

Bismarck & Missouri Valley.—This company has filed a charter in Dakota proposing the construction of a railroad from Sioux City, Ia., to Coal Harbor near Bismarck. This would not be deemed very important or notable event by a man of good judgment, familiar with the railroad situation in Dakota, but it is hailed by the Bismarck *Tribune* as follows:

"Another road! Think of it. The very prairie gridironed with roads coming to Bismarck. The glorious dawn is breaking and the sky is flushed with the roseate hue of prosperity."

Chicago, Kansas City & Omaha.—A charter has been filed in Kansas for this company which proposes to build a railway from Kansas City to Quincy, Ill., 23 miles. A. R. WILLIAMS of Topeka, WALTER BROWN, W. R. FORD, W. H. MILLER, E. B. EMMONS and others of Kansas City are interested.

Tabor & Northern.—This company has been organized and has made surveys for a railroad from Tabor, Ia., to Hilisdale, about 8 miles. T. MCLELLAND is President, and A. T. WEST, Secretary.

Venice, Marine & Eastern.—The projectors of this Illinois company have secured $61,000 in subscriptions to their capital stock and 17 miles of right of way near Venice, Ill. WM. H. JONES, Bank of Commerce Building, St. Louis, and FRANK MCCAMBRIDGE, of Venice, Ill., are interested.

Sioux City & Northern.—Messrs. Wakefield, Hill & Wingeland, of Sioux City, Ia., write us that contracts for the construction of 130 miles of the line will be let before April 12.

THE SOUTHWEST.

Existing Roads.

Missouri Pacific.—Wall street is greatly excited over the annual reports of this system, which have just been published. The New York *Times* comments as follows on the unfavorable showing.

The mileage increased from 4,607 to 6,193 miles, while gross earnings fell off $6,000,000. Taking the Missouri Pacific lines alone, it is shown that while gross earnings increased, net decreased, and the bonded debt having grown immensely, the interest charges were far higher than a year ago. Allowance being made for interest, taxes, rentals, etc., a deficit of $1,426,850 appears, against a deficit of $294,103 for 1886. There appears a mysterious item in the accounts of $4,702,785 as "floating debt," and there are memoranda of "uncollected balances from agents," etc., aggregating $5,547,967. These same entries were in the 1886 report, but they have grown tremendously, being in the aggregate about $3,000,000 bigger now than a year ago, while "cash on hand" has dropped from $2,728,785 away down to $614,372. In these three items there is a sudden disappearance of over $5,000,000. But that does not end the bad showing. In 1886 the funded debt of the Missouri Pacific was $30,000,000; now it is $44,302,000. Then the capital stock was $39,935,800; now is it $43,974,850. The company has over $18,000,000 more stock and bond than it had a year ago.

At the directors' meeting in this city a motion to declare the usual dividend of 7 per cent. was laid on the table, and no decision will be made until JAY GOULD'S arrival. As is well known, the present managers of the Missouri Pacific properties are much more famous as manipulators of the stock market than as men who build up and efficiently manage railway properties. It is therefore difficult to predict what course will be taken by them in regard to further extensions or permanent improvements.

St. Louis, Arkansas & Texas.—The tracklayers on the Altheimer branch are within 12 miles of Little Rock.—In answer to the letter of Hon. Jos. NALLE, Mayor of Austin, Tex., and President of the Austin & McGregor Ry. enterprise, in reference to aid in the construction of a line from McGregor to Austin, President FORDYCE replied as follows:

"The position of this company, relative to the operation and construction of a line from McGregor to Austin, has been defined in correspondence with the President of the organization. Since writing him, however, on the subject, financial affairs have changed somewhat on account of the uncertain condition of European affairs and the action of Congress relating to tariff measures now pending before the House. For the present, therefore, I do not think it worth while to offer any encouragement whatever in constructing a line from McGregor to your city by this company. It may be later on that there will be a better demand for American railway securities on the other side than there is at present in which event we may wish to communicate with you further."

San Antonio & Aransas Pass.—President LOTT has offered to build an extension from near Yoakim to New Braunfels, Tex., and have the line open for traffic by fall for a subsidy of $1,000 per mile and right of way. The distance is about 65 miles.

New Projects and Surveys.

Mountain View.—

HOT SPRINGS, Ark. March 17, 1888.

EDITOR ENGINEERING NEWS:—

This road is to be a passenger or excursion line only, commencing in the rear of the bath houses on the Government reservation running thence to the summit of Hot Springs Mountain, thence returning to the business portion of the city, bridging the valley thence along the top of West Mountain to the boundary of Government reservation. The length will be from 5 to 6 miles. There will be one high bridge over the business portion of Hot Springs from mountain to mountain. No contracts will be let or work done until the passage of the right of way bill now pending in Congress.

GEO. M. BAXTER, *Secretary.*

Wichita, Springfield & Trinidad.—Incorporated in Kansas by F. F. Stevens of Richfield and others, to build a railroad from Wichita to the State line, 240 miles.

Eddy, East Texas & Louisiana.—A project is being discussed at Eddy, Tex., for a railroad from that point *via* Centerville, Crockett, Homer and Hemphill to Alexandria, La. Dr. J. D. MOORE of Eddy is interested.

Winfield Belt.—Incorporated by GEO. W. ROBINSON and others to build a railroad through and around Winfield with branch lines to Wichita and Geuda Springs.

ROCKY MOUNTAIN & PACIFIC.

Existing Roads.

Nevada & California.—

RENO, Nevada, March 3, 1888.

EDITOR ENGINEERING NEWS:

The Nevada & California road was completed from Reno, Nev., northwest, 37 miles, sometime ago, and the line was extended 8 miles farther last year. Work is now in progress on the extension, 47 miles northward, and surveys are being made 30 miles farther, to Gradelain Plain. The line is owned by private parties, and we do our own work, letting no contracts.

ERASMUS GEST, *Manager.*

Northern Pacific.—The locating survey is in progress for the extension of the Helena Boulder Valley & Butte line to Butte City.

San Francisco & San Joaquin Valley.—Work has been stopped on this road to await the action of Fresno on the subsidy asked of $200,000. If the amount cannot be raised, it is stated that the road will continue down the valley and will not go to Fresno.

Rocky Fork & Cooke City.—H. C. DAVIS, the President of this Montana company, states that tracklaying will begin on the 46 miles already graded in a few days, and location has been completed for 70 miles farther to Cooke City. The Rock Fork Coal Co. has made considerable progress in developing the coal mines and will be ready to ship coal as soon as the railroad is completed. The rival project, the Billings, Clarks Fork & Cooke City has been trying to secure right of way across the Crow Indian reservation and wishes to reach the petroleum fields in northern Wyoming.

New Projects and Surveys.

Nebraska, Yuma & Southern.—Incorporated by GEO. F. WEED and others, of Yuma, Col., to build a railroad from that point to River Bend, on the Kansas Pacific Ry.

San Diego & Cuyamaca.—This California company, at a recent meeting, voted to extend their line beyond the Julian Mining region to Los Palmos, on the Southern Pacific, and from there to the Needles, a total distance of 250 miles from San Diego. R. W. WATERMAN, of San Diego, is President.

Contracting.

Tank.—(CORRECTION).—The bid of George Miles, to whom was awarded the contract for the iron tank for the Boston Water Board, was $2,420 and not $2,620 as stated on page 214; being the lowest and not the second lowest bid.

Stand-Pipe.—E. Hodge & Co., of East Boston, Mass., have been awarded a contract by the New England Construction Co. for a stand-pipe 30 ft. diameter and 80 ft. high at Franklin, Mass.

Street Cleaning, Etc.—The Board of Contract & Apportionment, Albany N. Y., has awarded contracts as follows: Wm. Muckle, Albany, removing street dirt in 1st, 2nd and 3rd districts, $4.59 per team per day; Ezra Bush, Albany, $4.94 and $5.15 per team per day for 4th and 5th districts.—A. J. Lamboy, removing night soil, dead animals, etc., $1,750.

Electric Railway.—The City Electric Street Ry. Co., Little Rock, Ark., has nearly completed the first mile of track and has the second mile well under way. Contracts for the next section of 1¼ mile were let this week, and probably 6 or 8 miles more will be built this season. F. J. H. RICKON, Engineer.

Street Railway Material.—The Decatur & Moulton Heights Street Railway Co., Decatur, Ala., is receiving proposals for 72 tons of 16 lb. steel rails, 5,000 lbs. of spikes, 1,000 lbs. of splice plates, and 6,000 sawed oak cross ties; also for excavating 3,900 cu. yds. of earth, laying track and grading. Address P. JONES, Chief Engineer.

Bridge Masonry.—The contract for the piers and abutments of the new bridge over the Westfield river at Salmon Falls, Mass., has been awarded by the Berlin Iron Bridge Co. to Geo. M. Atkinson & Co., of Palmer, Mass.

The contract for the masonry of a bridge across the Clinch river, near Lebanon, Va., on the Clinch Valley R. R., has been awarded by McMahon, Green & Son, to H. M. Crosby, of Wytheville, Va.

Lock Tender's House.—The following proposals for constructing a lock tender's house at Tuscaloosa, Ala have been received by Major A. N. DAMRELL, U. S. Engineer Office, Mobile, Ala.: Wm. Miller, Tuscaloosa, $1,990; O. Caldwell, Mobile, $2,250; W. L. Campbell, Mobile, $2,430; J. H. Gardner, New Orleans, La., $2,440. The contract was awarded to Wm. Miller.

Sewerage.—The following proposals for branch sewers at Fort Riley, Kan., were opened March 13 by Capt. GEO. E. POND, A. Q. M., U. S. A.: Jas. Tuliy, Junction City, Kan., $1,445; J. O. Heaton, Junction City, $1,990; D. & S. Griese, Junction City, $2,077.28; J. Shaw, Kansas City, Mo., $2,457.50. The bids were for the work complete, including 4,175 ft. of 6-in. pipe sewer, at an average depth of 8 ft., 5 manholes and 1 flush tank with Field's syphon. W. H. STAIB, C. E., is Superintendent of Construction.

Sea Wall.—The following proposals for constructing a sea wall on the Roxbury canal have been received by the Water Board, Boston, Mass.: Chas. H. Edwards, Boston, $5,427.50; Metropolitan Construction Co., Boston, $5,735; Thos. A. Rowe, Boston, $5,784.80; C. T. Derry & Co., Boston, $6,096; Boynton Bros., Boston, $6,349; McInnis & Parker, Boston, $7,528.50; H. W. Phillips, Quincy, $8,263.50; Collins & Ham, Boston, $9,369.50; H. W. Pike & Co., Cambridge, $9,697.

Railroad Work.—Messrs. Wakefield, Hill & Wingeland, Civil Engineers, of Sioux City, Ia., have the following work in hand: the Sioux City rapid transit line 2 miles of double track elevated and 2 miles of surface road; two motor lines in the city, 3 and 3½ miles long. F. A. HILL of this firm, is incharge of all the new construction of the Illinois Central in Iowa. About 130 miles of the Sioux City & Northern R. R. will be let in a few weeks. The firm is also landscaping 1,000 acres in Highland and Riverside parks, Sioux City.

Pumping Engines.—The following proposals for a pumping engine of 10,000,000 galls. daily capacity and for the purchase of the two 5,000,000 galls. Worthington engines have been received by the Trustees of the Water-Works, Toledo, O.: Geo. F. Blake Mfg. Co., New York, horizontal engine, $34,975, no bid for the old engines; Holly Mfg. Co., Lockport, N. Y.; horizontal rotative engine, $42,000 and $49,000, vertical engine $55,000, old engines $7,500; Henry R. Worthington, New York, horizontal engine $43,600, vertical engine $49,750, old engines $2,000; Knowles Steam Pump Co., New York, horizontal engine $45,000, old engines $10,000.

Street Sweeping Machine and City Work.—The following proposals for a street sweeper were received March 13 by the Board of Public Works and Affairs, Nashville, Tenn.; F. E. KUHN, Secretary: W. C. Oastler, New York, $300; Geo. C. Howard, Philadelphia, $320; J. H. Fall & Co., Nashville, $348. The contract was awarded to W. C. Oastler.—The Board is preparing bills to be submitted to the next council asking appropriations for $18,000 for granite pavements, and $11,500 for creosoted brick pavements on the principal streets, $25,000 for circular brick trunk sewer.

Water-Works.—*Paris, Ky.*—Three proposals were received by the Water Committee: Davenport & Co., of Charleston, W. Va., proposed to furnish a supply by direct pressure, 65 fire plugs, $2,500 per annum. M. Thompson, Bradford, Pa., 75 plugs, $2,500. Cosby & Glenn, New York, 55 plugs, $3,750.

The Inter-State Construction Co., of East St. Louis, Ill., has been incorporated to construct railroads, bridges, etc., and to operate mines; JAMES CAMPBELL, N. B. MUNSON, JOHN SCULLIN. Capital stock, $800,000.

The Atlantic & Pacific Ship Railway Co. has been incorporated by JAMES ANDREWS, of Allegheny, Pa.; P. SANFORD ROSS, MORRIS ROSS and WM. ROSS, of Newark, N. J., and WM. B. ELY, of Orange, N. Y. Capital stock, $100,000.

Street Railroad.—J. C. Rodemer, of Gallatin, Tenn., has been awarded the contract for the construction of the West Nashville Street Railway.

The Dougherty Cable Traction Co. has been incorporated by F. D. DOUGHERTY, E. N. WILLIAMS, J. H. DALE, of Philadelphia, Pa., and CHARLES WHITE, of Washington, D. C., to build cable railways. Capital stock, $500,000.

City Hall.—T. D. ALLEN, architect, of Minneapolis, Minn., has been awarded the contract for preparing plans and specifications for a fine brick and stone city hall at Superior, Wis., to cost about $25,000.

Stone.—The following proposals for furnishing granite for bulkhead or river wall were opened March 16 by the Docks Commissioners, New York City: J. Goss, Jr., $1.03 per cu. ft.; Charles Guidet, $1.45. The contract was awarded to J. Goss, Jr.

Electric Lighting.—No bids were received by OBED HOBE, City Clerk, Urbana, O., March 17, in answer to the advertisement for furnishing and maintaining 15 to 40 street arc lights and 100 incandescent lights, and operating the same for 5 years.

Water-Works Material.—The Water-Works Department of Kingston, Ont., Canada, is soliciting circulars and information from manufacturers of pumping engines, stand-pipes; pipe, hydrants and valves; filters, etc.

Brick and Cement.—The following proposals have been received by J. S. VERNER, Secretary of the State House Commissioners, Columbia, S. C.; Brick; T. W. Stanland, of Summerville, $10 per 1,000: C. A. Guignard, of Columbia, $10. Cement; Lorick & Lowrance, of Columbia, $1.55 per barrel: Fleming & Devereux, of Charleston, $1.68; C. O. Brown & Bro., of Columbia $1.78; J. M. Mayhew, of Columbia, $2. The contracts were awarded to T. W. Stanland, for brick, and Lorick & Lowrance, for cement.

City Hall.—The contract for the city hall at Pueblo, Col., has been awarded to A. N. Prowell. The cost will be about $46,000.

Stand-Pipe.—The Board of Water Commissioners, Galveston, Tex., have awarded the contract for the stand-pipe to Riter & Conley, of Pittsburg, Pa.

Water-Works Supplies.—The Water Committee, Lancaster, Pa., has awarded contracts as follows for supplies for 1888: Pipe, Mellert Foundry & Machine Co., Reading, Pa., 4-in., $31; 6, 8 and 10-in., $29.50; 12, 20 and 24-in., $29. Valves, ferrules and hydrants, W. P. Cummings. Specials, R. C. McCulley, 2¾ cts. per lb. Lead, Flinn & Breneman, $5 60 per 100 lbs. Digging and refilling trenches, John L. Aucamp, 17 and 70 cts. per cu. yd. for rock and earth. Hauling pipe, J. W. Musser, 40 cts. per gross ton.

Earthwork.—The following proposals for 40,000 cu. yds. of excavation and filling at Woodhaven, N. Y., have been received by W. H. PITKIN, Albany, N. Y.: D. Cuozzo, 51 E. Houston St., New York, 27 cts. for excavating streets and blocks, 49 cts. for forming and rolling streets and sidewalks; T. P. Kinsley, Syracuse, N. Y., 20 cts., 30 cts.; J. E. Brooks, 48 Dey St., New York, 20 cts., 90 cts.; L. I. Wright, Newtown, L. I., 20 cts. for excavating: Jas. Walsh & Co., 872 Broadway, Brooklyn, 35 cts., 90 cts.; Gallagher & Son, 685 Butler St., Brooklyn, 25 cts., 30 cts.; E. J. Curtin, 810 Classon Ave., Brooklyn, 30 and 25 cts. for excavating streets and blocks; T. S. Jenkins, Gravesend, L. I., 19 and 18 cts. for excavating streets and blocks, 30 cts. for forming and rolling.

Pipe and Hydrants.—The Water Commissioners, Lincoln, Neb., received the following proposals March 13: Dennis Long & Co., Louisville, Ky., $10.99 per ton for pipe, $59 per ton for specials; Chattanooga Foundry & Pipe Works, Chattanooga, Tenn., $31.39, $60; Ohio Pipe Co., Columbus, O., $31.75, $60. C. E. Hedges, Lincoln, Neb., $50 per ton for castings. F. C. Sholes, Lincoln, Neb., 16 in. valves, Matthews' hydrants and pig lead. The contract for pipe and specials was awarded to Dennis Long & Co., and for hydrants and valves to F. C. Sholes. I. L. LYMAN is Water Commissioner.

Reservoir Work.—The following proposals for work at the East Park reservoir, Philadelphia, Pa., have been received by LOUIS WAGNER, Director of Department of Public Works: Lining northeast section: Filbert & Porter, Philadelphia; brick, $1.12 per sq. yd.; concrete, $1.12 per sq. yd.; Lewis Grant, Pottsville, Pa., $1.16, $1.16; R. C. Ballinger, Philadelphia, $1.15, $1.93; Philadelphia Improvement Co., Philadelphia, $1.22, $1.22; American Artificial Stone Co., Philadelphia $1.25, $1.25. The contract was awarded to Filbert & Porter.—Coping stone for gate houses; W. C. Cunningham, Philadelphia, $994.01; J. Walter Maxwell, Philadelphia, $1,730.29. The contract was awarded to Wm. C. Cunningham.

Scoria Paving.—The Chicago Street Department will lay an experimental pavement of scoria, or refuse from the furnaces at the iron works. It is said that the cost is only about $1.75 a yard, while granite paving costs $3.60 to $4.

Concrete Foundations.—The following proposals for additions to the concrete foundations of the U. S. custom house at Galveston, Tex., have been received by Superintendent N. J. CLAYTON: Thomas Lucas; broken stone, $2.85 per cu. yd.; sand, $1.75 per cu. yd.; cement, $1.90 per bbl.; excavation and laying concrete, $2.25 per cu. yd. F. Biermann; stone, $2.65; sand, $1.65; cement, $1.75; excavation and laying, $3.75. I. Heffron; stone, $4.25; excavation and laying, $2.25; G. H. Henchman, stone, $5; cement, $1.50.

Boilers.—The Board of Public Affairs, Cincinnati, O., has awarded contracts for boilers as follows, on the recommendation of Superintendent MOORE: For the Front St. pump house, Heine Safety Boiler Co., $17,115; for the Hunt St. pump house, Laidlaw & Dunn, 2 Galloway boilers, $10,430 each.

Pier Work.—The following proposals for building a wooden pier and crib bulkhead at E. 46th St., East river, and repairing the existing crib bulkhead, were received by the Docks Commissioners, New York City, March 16: O'Connell & Coffey, new bulkhead and repairs, $3,350; new pier complete, $13,000; riprap stone, 85 cts. per cu. yd.; total, $17,752.50: John D. Walsh, $2,500, $14,054, 80 cts., $17,874: J. H. Staats, $3,100, $13,610, 80 cts., $18,030; John W. Flaherty, $2,948, $14,445 70 cts., $18,548; Joseph Walsh, $3,321, $15,000, 90 cts., $19,805. The contract was awarded to O Connell & Coffey.

Sewers.—The following proposals for sewers at Greenbush, N. Y., have been received: Section 4, Adam Miller, Saratoga, $10,350.50: John McEncroe, Schenectady, $11,596; Van Vranken & Clement, Schenectady, $11,895.50; John B. Doyle, Cohoes, $14,043.50; M. E. Dunn, Greenbush, $15,188.50—Section 5, Adam Miller, $11,327; John McEncroe, $13,397.50; Wm. Stanton, Cohoes, $13,956; Van Vranken & Clements, $14,366.50; John B. Doyle, $15,737.50; M. E. Dunn, $21,685.50,—Section 6, Adam Miller, $10,658.50; John McEncroe, $11,005; Van Vranken & Clements, $11,835; Wm. Stanton, $12,013; John B. Doyle, $13,057; M. E. Dunn, $13,102.—The prices ranged as follows: Sewer pipe, from 5 to 12 cts. for 8-in. to 8 to 30 cts. for 20-in.; drain tile, 6 to 22 cts.; iron pipe, 60 cts. to $1.40 for 15 in., and 20 cts. to $2 for 10-in; manholes, $38 to $44; catch basins, $30 to $49; flush tanks, $30 to $48; lampholes, $1 to $3.50; paving, 15 to 80 cts. per sq. yd.; repairing, 6 to 30 cts. per lin. ft.; excavation, from 24 to 45 cts. per lin. ft. for under 5 ft. depth to $2 to $3.10 per lin. ft. for 21 to 22 ft.

The proposals for material were as follows: John McEncroe, Schenectady, $28,645.90; Wm. N. Calender, Greenbush, $27,310.90; Carpenter & Woodruff, Troy, $27,792; Davitt & Fuller, Albany, $27,840.39; C. O. Yates, Schenectady, $28,765.40; Charles Millar & Son, Utica, $28,805.30; Wm. J. Halpen, Albany, $30,167.20; Knowles, Taylor & Anderson, East Liverpool, O., $30,456.34.—The prices ranged as follows: sewer pipe, from 23¾ cts. to 29½ cts. for 8 in. to $1.60 to $1.78 for 20-in.; drain tile, 2 to 3 cts. for 4-in. and 4 to 7 cts. for 6-in.; Rosendale cement, 80 cts. to $1.20 per barrel; special castings, 1¾ cts. to 2¾ cts. per lb.; cast-iron pipe, 1½ to 1¾ cts. per lb.; set stone for catch basins, $15 to $30; flush tanks $23 to $31; fittings for flush tanks, 75 cts. to $4; blue stone, 10 cts. to $1 per ft.; wrought-iron, 2 to 5 cts. per lb.; lead, 4½ to 6 cts.—The engineers are LANDRETH & FITZGERALD, of Schenectady, and RICHARD PRESCOTT, of Albany.

Dredging.—The following proposals for dredging in Cheboygan harbor have been received by Lieut. Col. O. M. POE, U. S. Engineer Office, Detroit, Mich.: Chauncey E. Mitchell, Ludington, Mich., 14⅛ cts. per cu. yd., scow measure; Chas. F. Dunbar, Buffalo, N. Y., 43 cts.; Carkin, Stickney & Cram, East Saginaw, Mich., 44 cts.; Wm. Richardson, Buffalo, N. Y., 45 cts.; Hickler & Green, Sault Ste. Marie, Mich., 46 cts.; L. P. & J. H. Smith, Cleveland, O., 69 cts.

Pipe and Castings.—The following proposals have been received by the Water Department, St. Louis, Mo.: Shickle, Harrison & Howard Iron Co., St. Louis, 670 tons of 36-in. cast-iron pipe, $25.45 per ton, $17,051.50; 35 tons of specials, $57.90 $2,026 50; Dennis Long & Co., Louisville, Ky., $28.75, $19,262.50; $73, $2,555; Addyston Pipe & Steel Co., Cincinnati, O., $29, $19,430; $75, $2,625; R. D. Wood & Co., Philadelphia, Pa., $29.95, $20,066.50; $59, $2,065; St. Louis Iron & Machine Works, castings, $68, $2,380. The contract was awarded to the Shickle Harrison & Howard Iron Co.—For one 36-in. check valve, St. Louis Iron & Machine Works, $1,038.90; Fulton Iron Works, $1,345. The contract was awarded to the St. Louis Iron & Machine Works.

Paving Prices.—The following are the prices of the engineer's estimate for street work, proposals for which will be received April 9: O. N. GARDNER, City Engineer, Lincoln, Neb.: granite paving, $2.68 on sand, $3.10 on broken stone and sand, $3.25 on concrete; sandstone paving, $2.63, $3.05, $3.20; brick paving, $1.85, $2.25, $2.40; 6-in cedar blocks without paving cement, $1.40 on sand and plank, $1.66, $1.79; 6-in. Bois d'Arc blocks with paving cement, $3.25, $3.65, $4; sheet asphalt, $3.10 with 5 years and $3.60 with 10 years guarantee; paving cement, 22 cts. per sq. yd.; 4 and 5-in. curbing, 85 and 93 cts. per lin. ft.; 5-in. gutter stone and crosswalk stone, 78 cts. per ft.; 24 × 20 in. corner blocks, $8 each; 4-in. drain tile, 8 cts. per lin. ft.; excavation, 40 cts. per cu. yd.; concrete, $6.50; sand, $1.50; gravel, $3.65; broken stone, $3.25.

Proposals Open.

Trenching.—For about 18 miles pipe line. W. H. SHACKLETON. Superintendent, Consumers' Gas Trust Co., Indianapolis, Ind.

Reservoir.—Plans and specifications on file. WM. J. CATHCART, City Clerk, Columbia, S. C. March 26.

City Works.—Street improvement and sewers. MARTIN FINCK, Clerk of Board of Public Works, Jersey City, N. J. March 26.

Water-Works Supplies.—Stop valves, 150 6-in., 5 8 in., 5 10-in., 10 12 in., 2 15-in., 12 20-in., 1 30-in., 4 36-in.; also 200 underground fire plugs. Separate bids. HENRY FLAD, President, Board of Public Improvements, St Louis, Mo. March 26.

Building.—Power house for electric light plant at the water-works, Bissell's Point. HENRY FLAD, President, Board of Public Improvements, St. Louis, Mo. March 27.

Water Pipe.—Cast-iron pipe; 300 gross tons of 12-in. 600 tons of 6-in. THE BOARD OF PUBLIC WORKS, Providence, R. I. March 27.

Bridge.—Wrought-iron Pratt truss bridge, single intersection, over Gunpowder Falls, 20 miles from Baltimore. Through bridge 175 ft. 1 in. between pin centers. 11 panels, 25 ft. depth of truss, 16 ft. wide in clear. Live load 1,200 lbs. per lin. ft. WM. H. SHIPLEY, Superintendent of Bridges, Morse Building, Baltimore, Md. March 27.

Pumping Engines and Pipe.—Two duplex power pumps, 1,500,000 and 750,000 galls. Also 270 gross tons of 3, 5, 6, and 8-in. cast-iron pipe. JOHN F. GROSS, Secretary, Water-Works Committee, Welland, Ont., Canada. March 27.

Fire Department Supplies.—Three La France improved nest tube boilers, turntable hook and ladder truck, Hayes extension ladder truck, 2 hose tenders, 20,000 ft. of 2½-in. circular and 10,000 ft. of 2½-in. balanced hose. THE FIRE DEPARTMENT, 157-159 E. 67th St., New York City. March 28.

Sewers.—Main and lateral sewers. JAMES BROWN, Comptroller, Allegheny, Pa. March 28.

Flagging Sidewalks.—JOHN P. ADAMS, Commissioner of the Department of City Works, Municipal Building, Brooklyn, N. Y. March 28.

Water and Drain Pipe.—Furnishing and laying 1,812 ft. of 6-in., cast-iron water pipe, 5 valves and 6 hydrants: also 1,685 ft. of 8 in. vitrified drain pipe, 19 4-in. Y inlets and 5 manholes. A. MCGONNIGLE, Chief Quartermaster, U. S. A., San Antonio, Tex. March 28.

Street Work.—Regulating, trap-block paving and granite-block paving. THE COMMISSIONER OF PUBLIC WORKS, 31 Chambers St., New York City. March 28.

Pier Work.—Removing old pier and building a new wooden pier at W. 51st St., North river. THE DOCK COMMISSIONERS, Pier A, North river, New York City. March 28.

Railroad.—Grading for change of line on Pittsburg division at Moss side, east of Walls. Price per cu. yd. Plans and specifications at the office of the Assistant Engineer, Lawrenceville station. WM. H. BROWN, Chief Engineer, Pennsylvania R. R., 233 S. 4th St., Philadelphia, Pa. March 29.

Sewer.—Central viaduct sewer. W. P. RICE, City Engineer, Cleveland, O. March 29.

Water-Works.—Complete system. P. A. BRUNDAGE, City Clerk, Tecumseh, Neb. March 29.

Stone.—For lock in the Kentucky river at Beattyville, Ky.; about 4,601 tons. Major AMOS STICKNEY, U. S. Engineer Office, Louisville, Ky. March 29.

Supplies.—Piles, screw bolts, nails, iron work, rope, stone, etc. Major A. M. MILLER, U. S. Engineer Office, St Louis, Mo. March 31.

Artesian Well.—Price per ft. for first 1,000 ft., next 500 ft. and additional depth for 8, 9 and 10 in. bore; lined with wrought-iron tubes. S. G. ARTINGSTALL, Engineer, Chicago, Ill. H. S. SALISBURY, City Clerk, Whitewater, Wis. March 30.

Sewer Pipe, Steam Heating, Etc.—For West Tennessee hospital at Bolivar. MCDONALD BROS., Architects, Louisville, Ky. April 2.

Masonry and Excavation.—Changing effluent sys-

tem of reservoir; open cut and tunnel excavation brick and stone masonry, etc. B. R. MORTON, Supt. of Water-Works, Newport, Ky. April 2.

Iron Work.—Drift bolts, about 60,000 lbs.; 36 sets of wrought-iron gate anchorages for locks on the Muskingum river. Lieut. Col. WM. E. MERRILL, U. S. Engineer Office, Zanesville, O. April 2.

Street Work.—Excavation, filling, granite and cobble paving, curbing, etc. THOS. J. LANAHAN, Clerk, Board of Contract, Albany, N. Y. April 2.

Railroad.—Grading, masonry and trestle work; from Rustburg, Va., 10 miles south; next 10 miles south; next 3-9 miles to Staunton river, including bridge masonry; bridge over Staunton river; from Durham, N. C., 10 miles north. J. W. GOODWIN, Chief Engineer, Lynchburg & Durham R. R., Lynchburg, Va. April 3.

Bridge Abutments.—For bridge over the Great Miami at Poast Town, O. Plans and specifications on file. RICHARD BROWN, County Auditor, Hamilton, O. April 3.

Plans for Court House.—Brick and stone structure; cost not to exceed $40,000. J. L. YOUNG, County Clerk, Tecumseh, Neb. April 3.

Water Pipe.—Cast-iron pipe; 10,000 ft. of 6-in. CHAS. GROSS, Registrar, Hobokon, N. J. April 5.

Engines.—Five Armington & Sims engines for the Washington navy yard. JAMES FULTON, Paymaster General, U. S. N., Navy Department, Washington, D. C. April 10.

Submarine Telegraph Cables.—About 4 nautical miles across the mouth of the Columbia river, Oregon; about 8 nautical miles for Martha's Vineyard, Mass. Gen. A. W. GREELY, Chief Signal Officer, Signal Office, War Department, Washington, D. C. April 16.

Water-Works.—Complete system, franchise to be granted. A. S. CREATH, Mayor, Greensburg, Ind. April 18.

Dredging.—In East Chester creek, N. Y. Lieut. Col. D. C. HOUSTON, U. S. Engineer Office, New York City. April 21.

Capitol Building.—Entire work or portions. GEORGE T. CLARK, Secretary, Board of Capitol Managers, Denver, Col. May 1.

WATER.

Water-Works.—*Maine.*—Randolph. Water is to be obtained this spring from the Gardiner water-works.

Connecticut.—Stonington. There was a unanimous vote taken March 15 in favor of the proposition of the Mystic Valley Water Co.; the company to furnish a supply to 42 hydrants from a reservoir with a capacity of 2,000,000 galls., with a head of 160 ft.——Mystic. There was only one vote against a similar proposition from the above company; there will be 47 hydrants supplied from the same reservoir. The annual rental will be $1,700 for Mystic, and $1,500 for Stonington.

New York.—Lockport. Dr. BRISTOL, of the Health Board, has stated that the majority of the wells from which the water supply is obtained, are in bad condition, being contaminated by sewage, and a supply of pure water must be obtained soon. A supply from Lake Ontario has been recommended,——Green Island. The Green Island Water Co. has purchased a building for a pumping station; the water will be pumped to a tank, but direct pressure can be used for fire purposes.—— Binghamton. The Water Commissioners expect to have all the old cement pipe, about 5 miles, replaced with 6 and 8 in. cast-iron pipe by the fall.——Sidney. An artesian water supply for fire and domestic purposes, is contemplated.

Ohio.—Fostoria. The vote on the revised franchise, taken March 14, resulted in 505 for and 35 against.

Tennessee.—Athens. The water-works are nearly completed, but the supply will be confined for the present to the company's property in North Athens. The brick pump house is located at the Ingleside spring, and has accommodation for two 50 H. P. boilers, and 2 pumping engines with a daily capacity of 500,000 galls. each. The stand-pipe is 50 ft. high and 12¼ ft. diameter. The pressure is about 100 lbs. in the 8-in. main.——Cleveland. Water and gas works are contemplated. Address, J. H. CRAIGMILES.

Georgia.—Columbus. The water company will improve its works at a cost of about $30,000——Rome. The East Rome Water Co. has been incorporated by J. M. REYNOLDS, G. M. BATLEY, and others, with a capital stock of $50,000.

North Carolina.—Greensboro. The Greensboro Water Co. has purchased a site for the stand-pipe, which will be 100 ft. by 30 ft.—— Fayetteville. The town commissioners propose to have a survey made of the city, for the proposed water supply and the water power canal.

Louisiana.—Baton Rouge. E. SMEDLEY, engineer for Smedley & Wood, of Dubuque, Ia., is in the city making preparations to commence work on the $75,000 water-works.

Mississippi.—Jackson. A company is to be organized to establish water-works and electric light plant.

Missouri.—Holden. The St. Louis *Globe Democrat* reports that there is some trouble over accepting the water-works put in by Quigley & Co., as the test did not satisfy the committee as to the height of fire streams; the contract calls for 4 streams 70 ft. high.

Indiana.—Huntington. The Citizens' Water-Works & Gas Co. has been incorporated by A. H. MILLER, F. H. POETKER, C. W. SCHWARTZ, P. BAMBERGER and H. ROTHERT, to put in water-works, gas works and electric light plant. Capital stock, $25,000.

Illinois.—Carlyle. The St. Louis *Globe Democrat* is also responsible for the statement that the City Council declines to accept the water-works for the reason that the water had not been forced to the agreed height at all points when the works were tested. At the test water was thrown 115 ft. high at several points, and at the remotest point was thrown 45 ft. high with stand-pipe pressure, and 100 ft. with engine pressure. The works cost $40,000 and the annual rental is to be $2,100 for water for fire purposes, watering places and a fountain. A suit has been commenced and the case will come before the Circuit Court at the May term.

Minnesota.—Owatonna. At the vote on the water-works question, March 13, the proposition was carried by a majority of 12.

Iowa.—Cedar Falls. The system of water-works to be constructed will cost $18,000.

Dakota.—Canton. The question of bonding the city for $10,000 for water-works has been voted upon and carried.

Nebraska.—Orleans. A proposition has been made to bond the city for $10,000 for water-works. A vote will be taken April 3, and will probably result in favor of the proposition.——Chadron. A water supply is proposed from Bordeaux creek, at a point 5 miles away. The works, including reservoir, will cost about $35,000. ——Hebron. At a meeting of the Board of Trade the question of putting in water-works was thoroughly discussed. The matter was favorably considered and the city trustees were requested to take the necessary steps to have works put in during the summer. M. H. WEISS is President, and A. H. HAZARD, Secretary, of the Board of Trade.

California.—Santa Cruz. At an election held March 5 on the issue of $100,000 5 per cent. bonds for water-works, there were 570 votes for and 250 against.—— Riverside. The improvement company is progressing with the pipe laying for the water-works, and the city is expected to have water supplied by April. There are now 2 artesian wells and a third is being sunk.—— Alameda. The Alameda Water Co. has been granted a franchise to lay pipes to convey water to the city from the artesian wells at Fitchburg. The city will have a water supply in a few months.——San Francisco. The Board of Supervisors has passed the water ordinance over the mayor's veto; the ordinance is to fix the water rates for the year ending June 30, 1889, and the reason given is that the Spring Valley Water Co. is making extensive improvements and additions to the water supply.

Texas.—Belton. The lease of the water-works has been sold by the lessee, MATTHEW DOW, to G. F. LINDSAY, of Belton, and WM. CLARKSON, Jr., of Corsicana; the transfer taking place April 1. The works are owned by the city and are reported to be in good condition.——Laredo. The water company has laid a line of 11-in. pipe across the Rio Grande to the island in front of the city.

Canada.—Yankton, Ont. The water-works will be completed this spring. The water will be pumped to a stand-pipe, and direct pressure will be available for fire purposes. The works are being built by J. D. RONALD, of Brussels, Ont.

New York Water Supply.—According to the last quarterly report of Commissioner NEWTON, the water supply for the last three months of 1887 was kept up to 110,000,000 galls. daily, thanks to the abundant rains of June, July and August. The loss of average pressure was only 4 ft. The same report recommends the increased use of water meters as particularly necessary to bridge over the 2 years yet required to complete the new aqueduct for service; there are now 16,552 meters in use, 1,970 having been placed in the year 1887.

Chatham, Ont. March 10, 1888.

EDITOR ENGINEERING NEWS:—Yours enclosing schedule of enquiries regarding water-works was duly received. Replying, I regret to say that ours are not sufficiently advanced to merit notice. We had a plan for a system submitted about a year and a half ago, but there was so much dissension existing anent the source of supply that it was dropped. The Municipal Council for 1888 have resurrected the scheme, and I think before the end of the year something definite will be accomplished, and that ere long Chatham will possess a system of water-works. We will take it on ourselves to keep you posted as matters progress. JNO. N. LUSCOMBE.

Yarmouth, Me. Feb. 23, 1888.

EDITOR ENGINEERING NEWS:—The population is 2,500. The present supply is from cisterns and wells, proposed supply from Royalls river, probably pumped to stand-pipe, with hydrant pressure for fire purposes. The works will be built by the Pumgustuck Water Co. and will cost about $30,000 to $50,000; no capital yet secured. No contracts let and date of beginning work uncertain. We have only organized our company and it is very uncertain when further progress will be made.

L. L. SHAW, *President of Water Co.*

Albany, N. Y.—The water complications existing for a long time in Albany, N. Y., have been untangled by the practical consolidation of the old and new Boards, with Gen. R. L. BANKS as President. The plans of Mr. VARONA have been adopted. The three months test of the driven wells of the Messrs. ANDREWS have been delayed somewhat by preparations for an increase of the supply to 15,000,000 galls. daily.

Cincinnati, O.—The recently appointed Water Supply Commissioners are at work studying the question of the best means of securing water. They have called to their assistance the following engineers:—HENRY FLADD, C. B. BRUSH, CHARLES HERMONY, DE WITT C. CREIGER, and A. FTELEY, all well-known in their profession. This Board of Experts is to deal with the following questions:

1. Is the location of the present intake in the Ohio river a proper one?
2. If so, is it practicable and advisable to enlarge and improve the present pumping station?
3. Is it practicable to supply Cincinnati with wholesome and desirable water from a system of driven wells?
4. What source of supply do you recommend?
5. What location do you recommend for the pumping station?
6. What method of clarification, if any, do you recommend?

Drainage in Wisconsin.—The surveys will be commenced at once for the Wind Lake canal; it will be 7 or 8 miles long and will run from Rochester to Wind lake in Racine county, and from Wind lake to Muskego lake in Waukesha county. The commissioners met at Waterford last week and directed surveys of the overflowed land to be made by WM. POWEIE, of Sussex, and B. F. S. FORT, of Racine.

Service Box for Water Closets.—A service box has been invented by WM. DAVIES, for preventing water waste in closets. It is of the syphon type and as it has no valve faces to wear out it is very durable. It is claimed that it cannot be tampered with and will not get out of order. It is being introduced by J. E HANNAH, of Winnipeg, Manitoba.

Electric Lighting Rates in Connecticut.—New Haven pays for 2,000-candle power lamps, running every night and all night, 50 cts. per night, or $182.50 each per year. ——Middletown pays for 2,000-candle power lights running every night until 11:30 p. m. $100 each a year; for 2,000 candle power lights running 20 days a month, $75 each a year and 35 cts. each per night over 20 nights a month—all lights running till 11:30 p. m.——Waterbury pays for 2,000-candle power lights running 312 nights until 1 a. m. $117 each a year, and for 1,200-candle power lights running the same hours and same number of nights $78 each a year.—— Bridgeport pays for 2,000-candle power lights running every night all night 50 cts. a night or $182.50 each a year.——Meriden pays for every night in the year, and running until 1 a. m., $150 each a year. ——Hartford pays under present contract for 337 nights, running all night, $142.51 for each light. Under the new contract made by the street board, $117.94 each, and gets under this new contract, as also under the present contract, 2,000-candle power lights running all night for 337 nights, and 1,200-candle power lights at a corresponding price, or at $78.63 each a year.

Aurora, Ill.—The electric light plant consists of an Armington & Sims high speed engine of 100 H. P., a boiler 16 ft. long and 60 ins. diameter, 36 3½-in. flues, with superheater, and two dynamos of 45 lamp power each; 75 double arc lamp of 2,000-candle power each, with meter, lightning arresters, switch boards, etc. The circuit consists of 27½ miles of No. 6 insulated copper wire, with 30 Brady mast arms. The engines and dynamos are located at the water-works pumping station. The cost of operating this plant for one year has been $4,413.09, divided as follows: Salaries $2,219.31, operating $1,820.85, machinery repairs $225.04, tools $26.30, miscellaneous $121.59. The lights are used till 6 A. M. on all dark and cloudy nights, and on the early and late parts of all nights as the moon goes; the average number of hours per night per year is 4 hours. The system is the Thomson-Houston. J. M. KENNEDY, City Clerk.

Austin, Minn.—The present supply, the works for which were completed in December, is obtained from artesian wells and the river. The water is pumped direct to the 4¾ miles of 3 to 10-in. cast-iron distribution pipe by 2 compound, condensing, duplex pumping engines, with a total daily capacity of 2,000,000 galls., built by the National Iron & Brass Works, of Dubuque, Ia., who had the contract for the works. The Galvin Iron & Brass Works, of Detroit, Mich., supplied the valves, and there are 52 Matthews hydrants. The ordinary pressure is 70 lbs., fire pressure, 175 lbs. Population about 4,000.

UofM

Gas Works for Sale.—EMERSON MCMILLIN, of Columbus, O., has for sale gas works in an Ohio city with a population of 6,000 to 7,000 inhabitants. Price $20,000.

Annual Reports.

Utica, N. Y.—RICHARD W. SHERMAN, City Surveyor, has issued his report for the year ending Feb. 20, 1888. A system of street cleaning by horse brooms, preceded by a horse sprinkler, has been introduced and works satisfactorily. During the year 6,436 ft. of street paving were laid: there are now 17.85 miles of pavement in the city and 75 miles of earth streets; as the soil is heavy, earth roads are objectionable, and it is recommended that no more macadam paving should be laid. A lift bridge and a new bridge over Starch Factory creek are recommended. The cost for bridge repairs was $1,154.71, the expenses for this item having been largely reduced by the filling up of the Chenango canal. A table of dimensions of the principal bridges is given. During the year 2.67 miles of cement and vitrified pipe were laid; the sewer system now comprises 28.33 miles of cement pipe, 3.17 miles of vitrified pipe, 6.9 miles of brick, and .08 mile of iron pipe; total 38.49 miles. The use of cement pipe is condemned and letters are quoted from officials of other cities showing that such pipe has not proved satisfactory. New sewers are recommended. The W. H. Clapp catch basin, as improved and used in Utica, is illustrated and described. The report is neatly printed, and is bound in cloth. It contains much information of general technical interest, in addition to the statements of work done, including the rules and regulations for sewers, drains, plumbing, etc., as adopted by the Sewer Commissioners, which are given in full. There is a summary of accounts and a table of contents. The work done by the City Surveyor's department has increased from $112,000 in 1886, to $167,000 in 1887.

Pawtucket, R. I.—The Sewer Commissioners have presented their report for the year ending Nov. 30, 1887, being their third annual report. In consequence of claims for damages made by parties whose property had been injured by explosions of naphtha gas in the sewers, the Board had the sewers examined by experts. During the year 1,051.16 ft. of brick sewers and 11,812 ft. of 8, 10, 12 and 15-in. salt glazed clay pipe sewers were laid; also 32 manholes, 25 lamp holes, 26 catch basins, 10 gutter grates and 5 automatic flush tanks (Rogers Field new pattern). Work is in progress on the Division St. sewer, and additional work is recommended. The part of the city on the Blackstone river watershed is all that is provided for in the present system of sewerage, but sewers are recommended for the part on the Moshassuck river watershed; the sewage from this section must either be pumped to Seekonk Plains and cared for by filtration, or taken by the city of Providence at the city line, and cared for with its own sewage at Fields Point. Surveys and plans are to be made for this system of about 3 miles of sewers, and $2,400 appropriated for the cost of the same. Sewage disposal is discussed, (discharge into river, chemical precipitation and land disposal) and a combination of irrigation and intermittent downward filtration, at Seekonk Plains, is recommended. There are 43,633.21 ft. of brick (egg shaped and circular), cement pipe (egg shaped and circular), iron pipe and salt glazed clay pipe; also 210 manholes, 178 lamp holes, 188 catch basins, 14 gutter grates and 22 flush tanks. A. R. SWEET is Engineer and Superintendent.

Baltimore, Md.—The Harbor Board has submitted its report for the year ending Dec. 31, 1887. The work done was chiefly removing the annual deposits of sediment from the harbor, docks and channels; there were 283,362 cu. yds., excavated and removed and the area dredged over was 171,383 sq. yds., making the average depth of cut about 4 ft. 11½ ins. The total expenditures on this account were $49,291.50, an average cost of 17.61 cts. per cu. yd., including maintenance and repair of tug, etc. New maps have been prepared and lithographed. New buoys are recommended in the channels. Work progressed on the seawall at Little Hawkins point, leaving 500 ft. of wall and 300 ft. of grading to complete the work. The estimate of work to be done during the present year is $92,786.77. The report of N. H. HUTTON, Engineer of the Harbor Board, gives details of the bids and prices for dredging and bulkhead work advertised during the year, and particulars of the expenditures on the several works and improvements.

RECORD OF NEW WATER-WORKS CONSTRUCTION.

(Specially Communicated.)

(CONTINUED FROM PAGE 211).

Clinton, Ill.—The works were commenced Nov. 1, 87, and are not yet completed; they were designed by J. W. NIER, of Kansas City, Mo., who was also Constructing Engineer. The building is ready for the pumps and 2 miles of pipe are laid; as work was commenced so late in the season the construction of the stand-pipe, which will be 120 ft. high, was postponed to the coming spring, and during the winter the water has been pumped directly into the mains. The works have been put in by the city; the pumping machinery was supplied by the Deane Steam Pump Co., of Holyoke, Mass.; the pipe and specials by Ripley & Bronson, of St. Louis, Mo.; the valves and hydrants by the Bourbon Copper & Brass Works, of Cincinnati, O.; the well was built by R. H. ROSS, of Clinton. The Water-Works Committee is composed of J. H. CONKLIN, W. H. WHEELER and A. P. MCHENRY. P. W. HENRY is Superintendent. The present population is estimated at 3,000.

Carlyle, Ill.—The works were commenced March 10, 1887, and accepted Aug. 16, 1887, they were designed by F. W. RAEDER, who was also Constructing Engineer. The water is pumped to a steel stand-pipe, 110 ft. high and 10 ft. diameter. There are 3½ miles of cast-iron pipe, 50 hydrants and 35 taps; the services are of galvanized iron. Average daily consumption, 20,000 galls. Ordinary pressure, 60 lbs.; fire pressure, 125 lbs. The annual expense is $200, and there is no debt. The annual revenue is $300 from consumers and $2,100 from the city; next summer the railroad company will be a consumer and about 100 consumers are expected, which will give a good income. The contract for the works was let to the Water, Light & Power Co., of St. Louis, Mo.; the contractor for masonry, buildings and foundations was Chas. Kalkbrenner, of Carlyle; for pumping machinery, Deane Steam Pump Co., Holyoke, Mass.; for pipe, specials and stand-pipe, Shickle, Harrison & Howard, St. Louis, Mo.; for hydrants and valves, Ludlow Valve Co., Troy, N. Y.; for trenching and pipe laying, J. T. Mephan, St. Louis. The prices paid were 4 cts. per ft. for trenching and 15½ cts. per ft. for pipe laying. The franchise is for 21 years; hydrant rental $48.33 each per annum and $45 for additional hydrants. The franchise is owned by the Carlyle Water, Light & Power Co.; capital stock, $50,000; President and Superintendent, J. J. RANDALL; Secretary, F. W. RAEDER. The present population is estimated at 3,000.

Bridgetown, N. S.—The works were commenced Aug. 17, 1887, and completed Dec. 20, 1887. They are owned by the town and were designed by Crafts & Forbes, of Boston; A. W. FORBES was Constructing Engineer. The contractors were Sutherland & Cochran, Kentville, N. S.; the pipes, specials, valves and hydrants were supplied by John Black & Co., of Glasgow, Scotland, and Bridgetown Foundry; the stand-pipe was built by Marshall & Piggott, of Clarence, N. S. The price paid for trenching and pipe laying was 25 cts. per ft. The supply is from North Mountain springs, at Clarence, the water flowing by gravity to a reservoir with a capacity of 750,000 galls. There are 4 miles of cast iron mains, 22 hydrants and 150 taps; the services are of galvanized iron. Average daily consumption, 15,000 galls. Ordinary and fire pressure, 100 lbs. The works cost $20,000; debt, $19,500; rate of interest, 5%. Annual expense, $1,400. Annual revenue, $300 from consumers (expected to be $800 in the future) and assessment $1,100. The works are owned by the town; JOHN L. COX is Superintendent. Water Commissioner, JOHN ERVIN. The present population is estimated at between 2,500 and 3,000.

TO BE CONTINUED.

Special Reports of Water-Works Construction.

The fourth yearly edition of the *Statistical Tables of American Water-Works* will be published as the ENGINEERING NEWS' MANUAL OF AMERICAN WATER-WORKS, and the change of name will be accompanied by such an enlargement of the scope of the work and such improvements in its completeness and correctness, as will make the volume *indispensable* to every manufacturer, engineer and contractor in any way interested in Water-Works construction and maintenance, and of great value to Water-Works superintendents and projectors of new works

We are now receiving reports from all parts of the country for use in compiling this book, and abstract the news of immediate importance below. We trust our readers will kindly aid us in making the Manual of American Water-Works as complete as we desire, by notifying us of any new works under construction or projected, which they do not see mentioned in our columns. Blanks for reports of existing works or works newly projected will be sent on request.

PEMBROKE, Ont., March 10, 1888.

EDITOR ENGINEERING NEWS:—Our town is not yet supplied with water-works, although several offers to construct works have been made. The citizens favor the project, but the Town Council is not yet ready for it. There is a good opening for some company to construct works, and we have plenty of water available for the proposed supply. Our population is 4,200.

A. J. FORTIER, *Town Clerk.*

WELLAND, Ont., March 8, 1888.

EDITOR ENGINEERING NEWS:—Water-works will be commenced this spring, and finished during the summer. Plans are now being made by WM. KENNEDY of Owen Sound, Ont. Money to construct the works has been voted by the town, and bids for materials will be asked in a few days. Direct pumping will be used, the water being taken from Welland canal. Two duplex pumps, having a combined capacity of 2½ million galls., will be driven by water power. There will be 3½ miles of cast-iron mains, and 28 fire hydrants. The ordinary pressure will be 60 lbs., and the fire pressure 150 lbs. The estimated cost of the works is $32,000, and our population is 2,500.

J. F. GROSS, *Secy. of Comm. on Construction.*

ST. SAUVEUR, P. Q., March 8, 1888.

EDITOR ENGINEERING NEWS:—Water-works will probably be built here next summer. Our population is about 3,000.

ANT. ROURNAN, *Secy. Town Corporation.*

DRUMMONDVILLE, P. Q., March 15, 1888.

EDITOR ENGINEERING NEWS:—We began the construction of water-works for this place in July, 1887, and will finish the works in December of the present year. The supply is taken from St. Francis river, and pumped to tanks. There are three miles of wooden mains, 70 taps, and 12 hydrants. The works will cost only $6,000 and will be operated at an annual expense of $100. The population is 2,000. The contract for pumping machinery was let to E. O. ROUDEAU, Sorel, P. Q.; for pipes and specials to JOS. LA CHAPELLE, St. Jerome, P. Q.; we bought the valves and hydrants from Garth & Co. of Montreal.

COMTOIS & POIRIER, *Owners and Builders.*

HERKIMER, N. Y., March 10, 1888.

EDITOR ENGINEERING NEWS:—The village has let the contract for a complete system of water-works to BECKWITH & QUACKENBUSH of this place. The contract price was $42,928 53. The works are to be commenced May 1, and finished by Aug. 30, 1888. They were designed by J. R. & F. K. Baxter, of Utica, N.Y., and consist of driven wells, a Knowles pump of 500,000 galls. daily capacity, a stand-pipe 25 ft. in diameter and 60 ft. in height, 7 miles of cast-iron mains and 51 hydrants. The population of Herkimer is 4,000.

CHAS. C. SPINNER, *Secy. Water Board.*

DETROIT, Mich., March 15, 1888.

EDITOR ENGINEERING NEWS:—Plans are now being made for an additional settling basin and for an additional engine and boilers, with houses for the same. Our works were originally established in 1828 and since 1877 we have been making continual extensions.

HENRY BRIDGE, *Supt. City Water Works.*

ROCKFORD, Ill., March 12, 1888.

EDITOR ENGINEERING NEWS:—We are now laying 20, 16 and 10 in. mains to new districts, and are adding 6,000,000 galls. pumping capacity to our plant.

JNO. T. LAKIN, *Supt. City Water-Works.*

NEILSVILLE, Wis., March 14, 1888.

EDITOR ENGINEERING NEWS:—There is some prospect of our works being extended this summer. If so, there will be added a new pump and boiler, a stand-pipe, and 8 hydrants.

R. F. KOUNTZ, *Supt. Village Water-Works.*

SCOTLAND, Dak.

EDITOR ENGINEERING NEWS:—

By order of the City Council, J. Y. McDonald, of Dubuque, Ia., has made plans and specifications for a system of water-works. J. P. Miller, 45 Michigan St., Chicago, has a contract for an artesian well, and was to begin work March 10. When the well is completed contracts will be let for mains, hydrants, etc. Our population is 1,500. The works are to cost about $15,000.

GEO. P. LINDLEY, *City Clerk.*

WEEPING WATER, Neb., March 10, 1888.

EDITOR ENGINEERING NEWS:—Our village has voted to issue water bonds to the amount of $13,000. The water supply will very likely be from a system of driven wells, as we want water for household as well as for fire purposes. Good water is obtainable in abundant quantities at not great depth. THOS. M. HOWARD.

Our work of collecting data for the *Manual* has been much facilitated by the commendable enterprise of Moffett, Hodgkins & Clark, of Watertown, N. Y. They have just sent us, in a tabulated form, data concerning the water-works owned and operated by their company since 1884. There are 27 of these, scattered through Ontario, New York, Ohio, Illinois, Wisconsin, Michigan and Minnesota. In these 27 towns there is a combined population of about 170,000 people; over 200 miles of pipes have been laid, and the sum total of the cost of the various works is about $3,500,000. The importance of the work which has been done is more apparent when we consider that the size of the towns range from 1,500 to 13,000 inhabitants, and that most of them would still be without water-works, were it not for the enterprise of this firm.